DISCOVERY

A MONTHLY POPULAR JOURNAL OF KNOWLEDGE

Edited by HUGH POLLARD

Volume V

JANUARY TO DECEMBER

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DISCOVERY

A MONTHLY POPULAR JOURNAL OF KNOWLEDGE

EDITED BY R. J. V. PULVERTAFT, B.A.

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A THORIANITE MINE IN CEYLON

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JOHN MURRAY, 50A ALBEMARLE STREET, LONDON, W.1.

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Vol. V, No. 49. JANUARY 1924. **PRICE 1s. NET.**

DISCOVERY. A Monthly Popular Journal of Knowledge.

Edited by R. J. V. PULVERTAFT, B.A., 23 Westminster Mansions, Great Smith Street, London, S.W.1, to whom all Editorial Communications should be addressed. (Dr. A. S. RUSSELL continues to act as Scientific Adviser.)

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Editorial Notes

AFTER announcing sadly its own demise in the December number of 1923, DISCOVERY returns to life in January 1924, under new conditions which promise an increase of its power to render service to the common well-being. This happy prospect is due in the first instance to the generous support of a guarantor who prefers to remain anonymous, and an educational trust with which he is connected, whose objects are nearly akin to, indeed largely identical with, those which DISCOVERY was founded to pursue. The two bodies of trustees, with the representative committee which has organised the help of scholars and scientists in the different branches of knowledge in support of the editors, are now engaged in considering the details of a joint scheme, which will be announced in due course.

* * * * *

But it may already be said that the distinctive characteristics of DISCOVERY, which have won it a place of unique authority among all English magazines, namely its guarantee of the soundness of its matter and its resolute effort to secure that it shall be presented in as simple and popular a form as is possible in every case, will be certainly preserved. Some new features may be added, to make its survey of research more and more complete and the practical fruits of research more and more conspicuous, especially in their contribution to that new, saner, freer, happier life of the whole human community which every man of every nation, creed, and party above all desires, after the whole fabric of society has been shaken by the convulsion of the War.

* * * * *

The announcement of our threatened extinction called forth a great number of encouraging letters. We are grateful to all who thus wrote. But this we must say, and with emphasis. Notwithstanding the succour that has come, it is for our readers to decide, in the long-run, whether the present revival is to be permanent or for a limited space of time. We would earnestly ask our readers to support us in every way. One way is to introduce DISCOVERY to a wider circle of friends and institutions; and for this purpose we beg attention to an announcement on another page. We also ask readers to take us into their confidence and help us with suggestions and criticism. One of the many letters which the announcement of demise brought us is printed in this issue. We hope the points raised in this letter of criticism and suggestion by our correspondent will engage the serious attention of other readers, and that they will give us the benefit of their own ideas and wishes on the specific points raised by him.

* * * * *

We regret that uncertainty as to the future involved the loss of our editor, Mr. Liveing, who has accepted engagements which do not permit him to continue in a position which he has filled to the great satisfaction of his readers. Only those who have been intimately associated with him in his work can realise the great service he has done to the interests of this journal, and we are happy in the knowledge that his advice and active help will be at the disposal of those whose duty it becomes to continue his work.

* * * * *

DISCOVERY knows no politics, in the partisan sense. Yet the General Election, which is just over, presented features of no small interest to all who are concerned for the growth of knowledge, and especially to those who are convinced of its importance to the well-being and healthy development of the community. Few of

us, probably, can recollect any election in which the voters, and even the candidates and their supporters, have gone about the business in so chastened and serious a mood. Violent conduct, though not wholly absent, has been remarkably rare; argument, good or bad, has been supplied, and demanded, in plenty.

* * * * *

The truth is, as even the keenest combatant would admit, that men and women have been constrained to think soberly by the shadow of grave danger—danger not now to our freedom in this island, or in the British communities overseas, but to the fabric of civilised life, in which, willy-nilly, the British peoples are partners, and no more; certainly not sole proprietors. This fact, suddenly brought home to most of us by the War for the first time, has unkindly persisted, driven deeper and deeper into our consciousness by the experience of the first five years of peace. For the first time, too, in the memory of men living, the Irish question, with its attendant passions, has been, for good or evil, completely withdrawn from the electoral scene.

* * * * *

Each of the three parties has given itself with a degree of sincerity, so conspicuous as to have been generally admitted even by the rival parties, to a study of social problems, the solution of which would seem to depend, almost wholly, upon adequate knowledge; for there appears no lack of courage in any of the parties to apply knowledge to practice, if only the knowledge that is needed can be found and understood. What is the cause or causes of unemployment? Of the dearness of living? Of the dearth of houses? Of the economic chaos of Germany? What is the normal effect of this or that proposed remedy? Would that effect be modified by present conditions?

* * * * *

Such are the most obvious examples of the riddles on which the plain man, and woman, have had to ponder as they listened, as they read, as they voted. And perhaps more than ever before in this generation, some sense of responsibility for questions abroad as well as for questions at home has been present in most people's minds. But to the student of history, of economics, of political science, to say nothing of other sciences, each of the questions has a large and definite background; each suggests factors which at least point in the direction of an answer. And in this election more than in most the demand for the knowledge of such factors has been clear, and large, and keen.

* * * * *

To all this the critical or cynical observer may reply that to him people seemed mainly to be anxious to vote in their own interest; but that more of them than usual were puzzled to know where that interest lay. Whatever truth, or untruth, such a comment may contain, the point for which, as friends of DISCOVERY, we contend, remains quite clear. People felt their want of knowledge; they wondered what was true. *They that wonder shall reign.* So runs one of the "Sayings of Christ"; and every good teacher knows and uses at least a part of its truth.

* * * * *

This is no time, then, for teachers and advocates of knowledge to be discouraged, or to give way to lions in the path. Rather we are admonished, by all means, especially by calling into alliance every friendly force that we can find, to continue our humble but, as we believe, vital work of conveying and interpreting to the many the achievements of the few. As these words are written, the season of Good-will is in sight. Without good-will knowledge is idle, or worse: but good-will without knowledge is deaf and blind.

* * * * *

The account of the excavation of the ancient city of David, which has recently been published in the *Daily Telegraph*, has solved a problem of very long standing. The city of Millo is mentioned in the Book of Kings, in Samuel, and in the Chronicles, and ancient tradition formerly located it to the west of Jerusalem. Professor Macalister, working under the auspices of the Palestine Exploration Fund, commenced excavation in a small field in the east of Jerusalem, on Mount Ophel. His labours were quickly rewarded. He discovered the walls of the Jebusite city which had occupied that site, long before the building of David's city, some 4,000 years ago. In addition he identified walls of later date, which once formed the proud city of the most romantic figure in ancient Jewish history. Buildings attributed to Solomon and Hezekiah were also found. So far, no inscriptions have been discovered, but much pottery of considerable interest and value was fortunately preserved. The marks of the masons' tools could still be seen on the stone.

The area excavated was small, and these preliminary successes give reason to hope for still greater discoveries in the future. Jerusalem, more than any other of the golden cities of the East, has a magic interest for Western nations. Perhaps that magic is apt to fade when one walks its narrow, dirty, and none too sweetly smelling streets to-day. The writer, however, looks back upon it as he saw it at sunrise from a war-time aeroplane, catching on its countless towers and minarets the gold of an Eastern dawn; set in its rugged hills with the gloomy depths of the Dead Sea behind it. From such a view-point it is possible to recapture, for a moment, the spirit of mystery and beauty with which Jerusalem must always be invested in the imagination. And under the spade of the modern excavator one sees the true Jerusalem rise again, from under the cover of centuries of turmoil, war, and oppression.

Editorial Policy

Suggestion and Criticisms

To the Editor of DISCOVERY

SIR,

Permit me the privilege of a reader to make a friendly criticism of editorial policy, and also a practical suggestion. The general idea behind the journal I take to be twofold. First there is the aim of popularising the body of verified or verifiable knowledge, alike that issuing from the side of science and from that of learning and scholarship. Next there is the endeavour to survey the growing points of science and of humanism; and in non-technical language to expound and explain the meaning and significance of these current advances. Underlying both endeavours, those of popularising the extant body of knowledge and surveying its advancing frontiers, there is an assumption of unity and order. But this assumption is too large to be taken for granted. To be approximately true, i.e. clear in thought and valid in practice, this concept of unity and order in science must be submitted to continuing examination, discussion, criticism; and I venture to submit that in this great and vital issue there is one effective way of procedure, and one only. The problems of unity and order must be taken simultaneously and in correlation with the pursuit of specialised knowledge. With few exceptions, so far, questions of systematic intent and generalised outlook in science have been left in the hands of writers and thinkers who belong to philosophy and metaphysics. Hence, I contend, a main source of the present tendency to a sterilising divorce between the specialised sciences and the philosophical interests.

Here assuredly is a gap which has serious consequences. It obstructs the coming together of diverse specialists; it keeps apart the men of pure science and the scholars of humanist learning; it hinders the repercussion of scientific thought on public opinion. The gist of the criticism I would bring to bear on the editorial policy of DISCOVERY is that, as yet, it has inadequately addressed itself to the considering of these dispersive tendencies of science, and seeking out, and promoting, the interests, which, if better cultivated, could be more effective in promoting the needed remedies.

I have tried above to put the case for a more deliberate pursuit of order and unity in science on the somewhat recondite grounds of advance in knowledge. Allow me next to restate the issue from the side of popularisation. For that purpose let us imagine, and briefly set down, the view which an outside critic, surveying the current disorderly field of science, might take. His argument would perhaps run as sketched below.

The Humanist Case

Against an approaching day of awakening, of genuine and growing interest in facts, in life, in civilisation, in possibilities, it is for the body of scientists themselves, those who search towards sciences of nature and civilisation, to be setting their houses in order, and with these their minds as well. And if public and government have so generally failed to see even the simpler meanings and values of what the men of science know to be profoundly vital and significant, is it not after all a good deal the fault of these scientists? Is it not "up to them" plainly to show forth this significance? General ideas, not bewilderingly multifarious particulars, are what the public needs. Admittedly it is no easy matter to give a really good popular lecture or demonstration, much less a comprehensive course of lectures through a whole science, or of demonstrations through its museums. For these must be at once within the comprehension of the intelligent woman and plain man of no special preparation, and yet must be able to bear the criticism of the specialist. When it comes to practice they must be definitely practical enough for the workman, for the business man, for the politician, and for the clergyman. In any case such expositions have to bear higher criticism still, that of the historian of science, and, even beyond this, of its philosophers: for the quest of philosophy is not something remote from life, as too many think, but is the order of thoughts and things—in relation to life—lived fully and lived well.

Cultivators of the sciences, it is generally assumed, believe they have a gospel, that of science, and they are not afraid to preach it: but have they really agreed how to preach it, or even what their gospel is? What are all these different sciences, each with its interminable details, its innumerable applications? Here is knowledge of all sorts, and "without knowledge the people perish"; but also here are the practitioners of science seemingly without any common vision of unity in their science; and "where there is no vision the people perish." To be sure, many of them go into the world and preach, but it is of their innumerable discoveries separately, or of their many inventions. Each of these is no doubt a positive panacea for something or other, now for antisepticating, again for energising, but what sort of a gospel is that? Sciences in snippets—excellent; medical or industrial appliances galore. But Science as unity, as synthesis, as synergy, as sympathy—of that they appear to have no common vision, and thus no gospel

at all. Whose fault, then, is it if the people perish? Assuredly not the people's. . . .

Continuing this line of criticism, as the humanist might state it, we can imagine it further developed by his investigation of causes underlying the present dispersiveness of science. He would no doubt emphasise the current severance of scientific research and scholarly erudition as one of the main causes that operate towards maintaining the ignorance of the people, the dullness of their teachers, and the mental apathy of their rulers. This sterilising of the sciences and the humanities, which has run its devastating course since the Renaissance, is, to be sure, now happily drawing to a close. The classics of Rome and Greece and Israel are to-day all being deciphered anew, by anthropologists and scholars working together; so that from primitive man, struggling, erect, and grasping tool and striking fire, and shaping cries into words, there is, we increasingly see, no real break to the coming of heroes and prophets, gods and muses, saints and sages. Better still, in this chequered ascent of life to man, of man to civilisation, long-eclipsed ideals of his greatest past begin to emerge anew.

As this emergence proceeds, a further possibility develops, which some call Higher Education, and others Applied Science, but assuredly both are, in a deep sense, one and the same: that which of old, Socrates, uniting homely imagery with highest, called the birth-helping of the spirit, and which he had also expressed in his art as a statuary of its incarnations. It is time, even, as some think, long past the time, for the scientist to understand the scholar, and so also forgive the latter's seemingly obscurantist tenacity; for has not the scholar striven in his own way to conserve and maintain the essentials of a pro-sociology, and when he, the scientist, was still a child at play among his sparks and explosions, among his minerals and fossils, his butterflies and flowers?

As the man of science matures, he sees that his ideas about nature are not what he has too long thought them—discoveries and systems of absolute truth, impersonally detached from his life and that around him—but are simply such facts as his personal circumstances and development have permitted him to see, and such theories about them as his social environment and heritage have enabled him and his fellows to form. The scholar for his part no longer writes histories of Greek science and philosophies which end with the Greeks, but continues these into the larger science of our own day, the returning philosophy of the opening one. Better still; after long repression, the interpretative scholar, even the scholar-poet, is reappearing. The mysteries, it may be, will before long begin to reopen, the muses to descend again, even the gods to return. Concretely this means that the City will be renewed: and its Acropolis be rebuilt, its groves replanted. With this renewal in life, in thought, in art, Public and Government, Education and Science, we may assume, will again go forward together.

Knowledge and Vision

Outlined, as above, in humanist terms, the case for unity of the sciences, and their unison with the humanities, can hardly fail to appeal to the many specialists who maintain a certain breadth of outlook. Let it be admitted, then, that the supreme need of science is a more ordered knowledge and a fuller and clearer vision. As regards Order, we remind ourselves that the logician has always stood for this, albeit also, too often, stood in the way. Still, at his best the logician has striven to make a Classification of the Sciences. That is an old and standard problem, from Bacon's day, and long before, to Spencer's; but, assuredly, it was never so much needed as to-day, nor proportionately so little attended to. Here and there some broad review appears, some fresh endeavour (witness Flint's *Scientia Scientiarum*, Karl Pearson's *Grammar of Science*, J. A. Thomson's *Introduction to Science*, etc., and in French and Italian a larger literature, though in Germany still less than with us); but few readers, and still fewer working men of science, ever spare a day to consider them. Yet before science can make good its claims in education, it must satisfy educators and administrators that its knowledge is not simply accessible, but is in useful and vital order. So long as it goes on offering merely its latest marvels at the British Association, or even its profitable and saleable units in its present variety-store of indefinitely numerous departments, science must in the main blame itself for its substantial exclusion from, or subordination within, the field of education.

A generation ago, the great generalisations of the Conservation of Energy, and of the Doctrine of Evolution, were holding the physical and the biological sciences together in students' minds, and Sociology was dawning, hopeful and young. Essential elements for this synthesis (as in ethics, psychology, æsthetics) were lacking to most, despite Comte's and Spencer's exhortations: still that triple unity was a great beginning. But in all the many fields of science, investigations have for the most part since (and so far needfully) turned to details. Those cardinal ideas seemed so established that professors, lecturers, and demonstrators, in their teaching, too much assumed them, and their successors have done the same; so this generation of the public has been allowed practically to ignore them.

The British Association has always shirked this problem of unity, and carried on its sections with but alphabetical labels; and its various specialist societies keep strictly within their fields, artificially walled in though they be. The naturally generalising societies—Geographical, Economic, Anthropological—have little dealings with each other, and with the Sociological Society perhaps still less. Even the Royal Society's *International Catalogue of Scientific Papers* rests on no serious classification of sciences, and it omits sociological studies beyond the simple anthropological level. Libraries, too, with all their recent endeavours towards classification of their ingenious cataloguing systems, are still by turns empirical and abstractly logical, more than truly classificatory. As for the Universities, where is there one in the whole world that has, as yet, grappled with the problem at all, or ventured seriously to consider, much less modify, the long outgrown and obstructive boundary-fences of its Faculties, Triposes, and Degrees? Yet what living man will to-day defend them? Only "practical administrators" overwhelmed with their burden of routine duties and correspondingly inhibited from critical thought.

The Growing Points of Science

All that has been said above, by way of criticism and suggestion, will, no doubt, be dismissed by many as generalities insufficiently related to current needs and possibilities. Well, let me try to sketch in a few sentences an outline of what would seem to be the main growing points to-day on the banyan tree of science. To begin with, we witness a veritable rebirth (as Sir Ernest Rutherford has called it) in the physico-chemical group. This, to be sure, bulks largest in the public eye, partly by reason of its startling transformations in fundamental concepts, and still more by its practical applications, as in wireless transmission. But we witness to-day also changes in the life-sciences, which, as some think, amount to a rebirth not less significant and transformative than that of the environmental sciences.

The "new psychology" has drawn to the observation and interpretation of mental process a great body of keen and thoughtful students. One of the learned societies, which recently announced a course of six lectures on recent advances in the newest branch of the "new psychology," had the unusual experience of finding its hall filled to overflowing, and people waiting in a queue in the expectation of being allowed to pay for standing room! There is also emerging a "new anthropology" (as it is beginning to be called), which finds readers for its books, and workers for its problems, in numbers growing with an acceleration amazing to old stagers in anthropological study. Again, there is unmistakable reawakening of interest in the deeper problems of biology. It focuses not on the rather technical issues of heredity and variation, but in the meaning, significance, interpretation of life. It is less concerned with the origins and past development of life, and more with the "purpose" of life, and its control towards opulence of living. To cite but a single instance in testimony, there is the thirty-page exposition of "The New Biology," which occupies the place of honour in the current (October) number of the *Quarterly Review*. The writer (Professor J. Arthur Thomson) closes his account of this newer biology on a clearly sounded note of life affirmative, life creative. He says at the end of his long article: "We are reaching a firmer control of life. The new biology in working out its evolution theory will do more justice to the living organism itself. It is not a passive power, but an agent with a will to live. It has a hand of hereditary cards, which it plays. The environment does indeed select it and its variations; but it often selects its environment. It is a psycho-physical being, Mind-body and Body-mind in one; and it shares in its own evolution."

Beyond biology, anthropology, and psychology, there is, or should be, in the group of life-sciences, one which complements and supplements the others. But sociology is slow to pass from its traditional attachments of abstract filiation. Still there are signs that even sociology is beginning to follow in the footsteps of psychology, and re-establish itself on an observational and genuinely interpretative basis, informed and guided by verifiable hypothesis. And careful observation would no doubt show, in current sociology, growing points towards a more naturalist reorientation; but as yet, no body of interpretative doctrine in this field has achieved that vague but realistic recognition of rebirth which expresses itself by general acclamation in the epithet "new." Nevertheless, given these newer doctrines in biology, psychology, and anthropology, it is a fair prediction that before long we shall witness also a rebirth in sociology.

Discovery in Logic

Now, returning to the editorial policy of DISCOVERY, let me put sharply the major point I would submit. Clearly to describe, for the benefit of its readers, those changes of outlook and interpretative insight which characterise these reawakenings in science is, I take it, an accepted aim of the journal. But is there not an implied obligation to go beyond the merely descriptive mark? Does not the reader want, and keenly want, something more than disparate accounts of the "new" in physico-chemistry, biology, anthropology, and psychology? He wants, I think

we may assume, a comparison and collation of all these advances; he wants a clear view of their interaction and correlation; he wants, in short, a vision not only of sciences, but of Science in its oneness, its meaning and significance, its "value" for himself and his world of contemporary thought and affairs. But does not that attainment wait for the coming of a Logic of Science which is also a Logic of Life? And if so, what advances towards this achievement are discoverable in progress to-day? Is it not a fair assumption, that in this field there are notable growing points to be discovered, if we seek for them amongst the more reflective workers in the various branches of research? This, then, is my specific suggestion—that to keep the readers of DISCOVERY posted in the advancing logic of science is a not less important function of the editorial office than to keep them abreast of actual progress. I am, etc.,

CIVIS.

Sir Ronald Ross and the Malaria Problem[1]

By Sir A. E. Shipley, G.B.E., F.R.S.

Master of Christ's College, Cambridge

Now I will explain to you what the law of diseases is, and from what causes the force of disease may suddenly gather itself up and bring death-dealing destruction on the race of men and the troop of brute beasts.—LUCRETIUS, *De Rerum Natura.*

SIR RONALD ROSS has written a full-dress autobiography, and he has written it very well. It is, as he tells us, intended for the general reader as much as for the medical man for, as he states, it is the laymen and not the doctors who rule the world.

Sir Ronald Ross is very justifiably full of divine indignation at the way in which the works of science are neglected by our politicians and legislators. A typical example of this occurred but a few months ago. Westminster Hall with its restored roof was reopened by the King, many speeches were made and many articles were written dwelling on the history of that noblest of Halls, and on the many dramatic episodes that had taken place in that stupendous building, yet, so far as I know, not a single speaker and not a single writer referred to the gifted entomologist who had made the restoration of the roof and the preservation of its old timbers possible. Historians are notoriously bereft of a sense of proportion, and whilst in many articles they dwelt upon the great scenes that had been enacted in the Hall, not one of them even remarked on what was perhaps the most dramatic and most important scene of all, the finding by a distinguished Professor of Entomology of the London School of Science of the larvæ of the beetles that had for decades been eating up the woodwork in the roof, and his still more remarkable application of a chemical compound which proved fatal to the beetle and all its works and made the beams whole.

Sir Ronald begins with his ancestry, which he deals with all too shortly. The Ross family had for some years been closely associated with India. Sir Ronald's father's commission in the Indian Army dated from 1841. From 1859 onwards the latter saw a good deal of service. His regiment, ordered up to Amritsar, then as now a danger spot, failed to receive the higher rate of pay which had been awarded to lower battalions. Consequently they mutinied, and the Commander-in-Chief disbanded the unit. Ross's father was then moved to Simla and on to the North-west Frontier and in time to the Kumaon Hills, where three days after the outbreak of the great Mutiny Ronald Ross was born. His first memories are of mountains, snows, rhododendrons, and fir-trees. In a notable paragraph the author draws attention to the fact that one can rarely remember anything of the first four or five years of one's life. "Is it possible," he asks, "that the child's brain-cells are changed and that he sheds his mind as he sheds his first teeth?" Yet it is true during these early years that the child learns to talk and to exercise a certain amount of self-control and judgment and to co-ordinate his movements, and it is certainly capable of reasoning, for it knows very clearly what it wants and by experience the best way to attain it. A typical instance of this failure of memory is the fact that Sir Ronald spoke Hindustani as well as English as soon as he could learn anything, but that on his return to India twenty-four years later he had forgotten every single word of the former language. When he was eight years old, in 1863, he was sent to England, where he lived with an uncle in the Isle of Wight. His education was rather miscellaneous and self-sought; but he immersed himself in the classics to such an extent that on one occasion his uncle exclaimed: "Why, the boy talks Elizabethan English!" As a schoolboy he seems to have had a considerable amount of leisure, which he largely devoted to zoological pursuits. He read the classics, but mathematics were his forte and his foible. He was no mean artist, having learned much from watching his father work on his admirable water-colour sketches, and in 1873 Ronald was bracketed first for Drawing in all England at the Oxford and Cambridge Local Examination. Indeed he wished to become an artist; but his father was opposed to that, and being of a

[1] *Memoirs: with a Full Account of the Great Malaria Problem and its Solution.* By Sir Ronald Ross. (John Murray, London, 24s. net.)

dreamy nature with a fondness for warm climates, he made no objection when his father insisted on his reading for the Indian Medical Service. He entered St. Bartholomew's Hospital in 1874 and was kept hard at work. In time he became dresser to Mr. Savory, a man of fine presence and dramatic oratory, but, as I remember him, a little vague about the aspirate. Whilst reading for his final examination, Ross took several voyages as a ship's surgeon, during one of which and the broad sunlight and the air of India. He was full of energy, thinking out problems of all sorts and going through a thorough course of the world's Poets, studying Italian, French, and German, and returning again to the Greek and Latin writers. He wrote a great amount of poetry and threw himself into the study of mathematics, in which subject he published several papers of recognised value. For a time he was stationed on the North-west Frontier, then he was

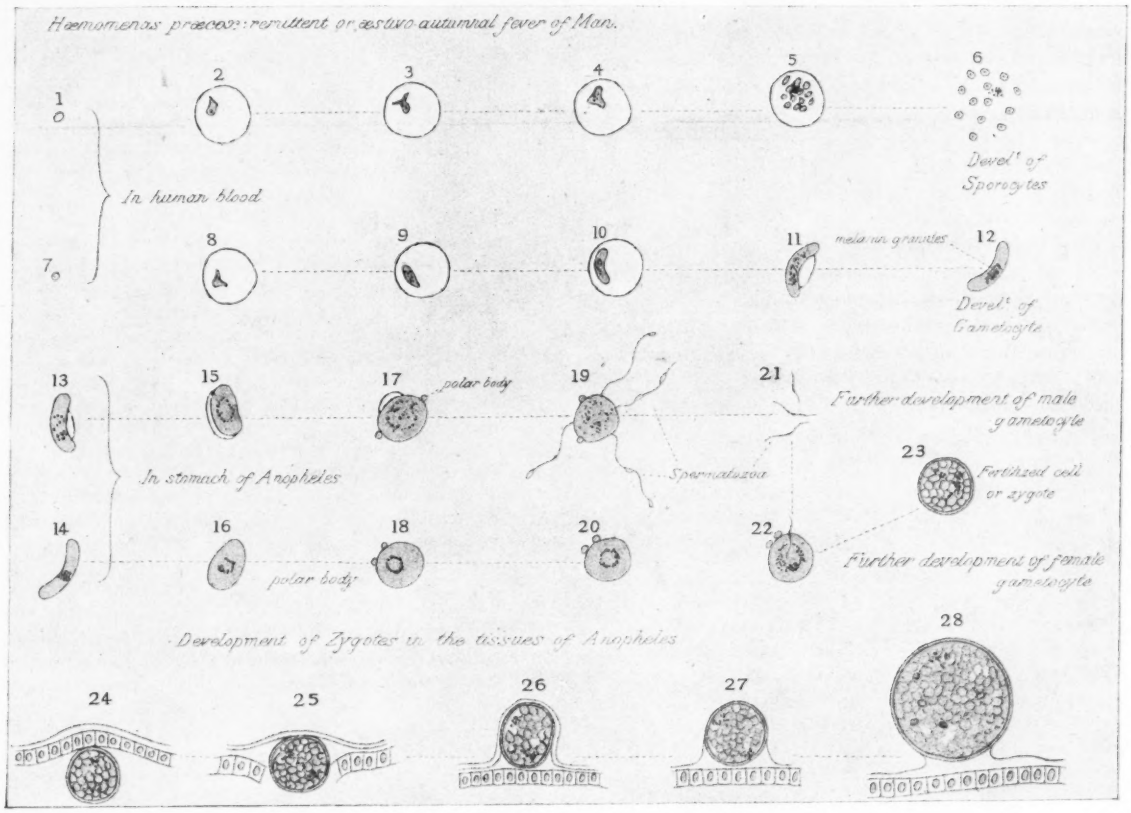

FIG. 1.—THE LIFE-CYCLE OF THE MALARIAL PARASITE

he wrote a whole Spanish drama, called *Isabella*. All through his life he has been constantly writing verse, blank or otherwise, plays, novels, with varying degrees of success. Having qualified early in 1881, he sat for the I.M.S., where he took the seventeenth place and began a course of special training at Netley, a place where he was thoroughly at home and very happy.

Early Days in India

In the autumn of 1881 Ross reached India and there began the varied, if somewhat monotonous, career of an army doctor. He rejoices in the change of climate transferred to Burma, the Andamans, and Madras. It was in the Andaman Islands that he wrote his first novel, entitled, *Child of the Ocean*. Then he moved to Madras, and here, after seven years' continuous work, he broke down. He was a bit discontented. Even now in his seventh year of service he had not yet received a "pucka" appointment, which meant the loss of 100 rupees a month. He had also been refused a year's furlough to England, to which he was entitled after five years' service. There had been mismanagement in the admission of candidates, and when Ross entered the Service in 1881 the junior ranks were

overcrowded, with the result that numbers were drastically cut down, so that there were now no junior officers to take his place if he could be given leave of absence. He felt, as all men feel under such conditions, an intense yearning for home, its cold weather and its cloudy skies, and when in 1888 he eventually left for home, he soon became a different man. During his furlough he married Miss Rosa Bloxham, and on their return to India the following year he was sent immediately on field service to Burma, a country whose beauties he thoroughly appreciated. In 1890 he was put in charge of the hospital at Bangalore, and there he remained three years, taking part in all the activities of the white man in an Indian Station.

In 1904 he was back again in Europe and had a great time in the Alps; but he really should not assign our well-known physician, Dr. Wherry, with whom he climbed, to the sister University!

Ross had attempted a great many things and achieved success in most of them; but he was neither satisfied nor entirely happy. He was now to embark on the great work of his life—a work which has brought him fame and honour, and which has done perhaps as much as any other contribution to science to relieve suffering and postpone death, and so make vast regions of our globe a fitting home for the white man.

Abraham Cowley foresaw it when he wrote:

> "Th' excess of heat is but a fable;
> We know the torrid Zone is now found habitable."

> "On March 28th [1895] I departed again for India, leaving my wife and three children at home. My age was thirty-eight and I had attained the rank of Surgeon Major in 1893, after twelve years' service."

Ross is most scrupulous in assigning to others their just share of the work in clearing up the tangled subject of malaria. At the beginning of Part II of his *Memoirs* he describes in detail all that has hitherto been known as to the problem of transmission of the parasite. He is just and fair all round.

On his return from India he suffered from innumerable disabilities. He could obtain no systematic works on mosquitoes. He was ignorant of the Romanowsky method of staining and, like everybody else, he was to a great extent searching in the dark. Finally, he was necessarily hampered by his routine work, and still more by the total inability of the higher authorities to even understand what he was trying to arrive at. Then, again, little or nothing was known about the structure of the mosquito's body, and to dissect these one after the other in a tropical temperature shows an amount of faith and devotion to the cause which is worthy of the highest praise. But for the cheering and inspiring letters of Sir Patrick Manson, the original suggestor of the mosquito-malaria theory, it is difficult to imagine how he could have stuck to his job.

The Great Discovery

The actual discovery—the discovery which has indelibly engraved Ross's name on the roll of Fame—is best described in his own words:

> "The 20th August, 1895—the anniversary of which I always call Mosquito Day—was, I think, a cloudy, dull, hot day . . . . After a hurried breakfast at the Mess, I returned to dissect the cadaver, but found nothing new in it. I then examined a small *Stegomyia*, which happened to have been fed on Husein Khan on the same day (the 16th), which was also negative, of course. At about 1 p.m. I determined to sacrifice the seventh *Anopheles* (*A. stephensi*) of the batch fed on the 16th, although my eyesight was already fatigued. Only one more of the batch remained.
>
> The dissection was excellent, and I went carefully through the tissues, now so familiar to me, searching every micron with the same passion and care as one would search some vast ruined palace for a little hidden treasure. Nothing. No, these new mosquitoes also were going to be a failure: there was something wrong with the theory. But the stomach tissue still remained to be examined—lying there, empty and flaccid, before me on the glass slide, a great white expanse of cells like a large courtyard of flagstones, each one of which must be scrutinised—half an hour's labour at least. I was tired, and what was the use? I must have examined the stomachs of a thousand mosquitoes by this time. But the Angel of Fate fortunately laid his hand on my head; and I had scarcely commenced the search again when I saw a clear and almost perfectly circular outline before me of about 12 microns in diameter. The outline was much too sharp, the cell too small to be an ordinary stomach-cell of a mosquito. I looked a little farther. Here was another, and another exactly similar cell.
>
> The afternoon was very hot and overcast, and I remember opening the diaphragm of the sub-stage condenser of the microscope to admit more light and then changing the focus. *In each of these cells there was a cluster of small granules, black as jet* and exactly like the black pigment granules of the *Plasmodium* crescents. As with that pigment, the granules numbered about twelve to sixteen in each cell, and became blacker and more visible when more light was admitted through the diaphragm. I laughed, and shouted for the hospital assistant—he was away having his siesta."

This was the first discovery of the malarial organism in the body of the mosquito, and it was no chance discovery. There are hundreds of different mosquitoes

in India, and Ross had been carefully dissecting hundreds if not thousands of these, not knowing which kind to investigate or where to look in the body for the parasite. Now he had found it, and he had made two discoveries simultaneously. He had found out the kind of mosquito which carries the parasite and the form and position of the parasite within it.

There was still, of course, much to be done. He held the key to the mystery, but the door remained to be unlocked. He had discovered the zygotes of the fourth and fifth day after infection, but what happened afterwards to the parasite had still to be investigated.

In 1898 Ross was compelled to carry on his research on the malaria in birds, as his superiors kept him away from areas where man was the victim of that fever. He now found the zygotes dividing up into innumerable spores and pressing their way through the coats of the stomach into the body cavity. By the middle of that year he was finding that these spores were more numerous in the thorax and the head than in the abdomen, and finally he traced them to the salivary

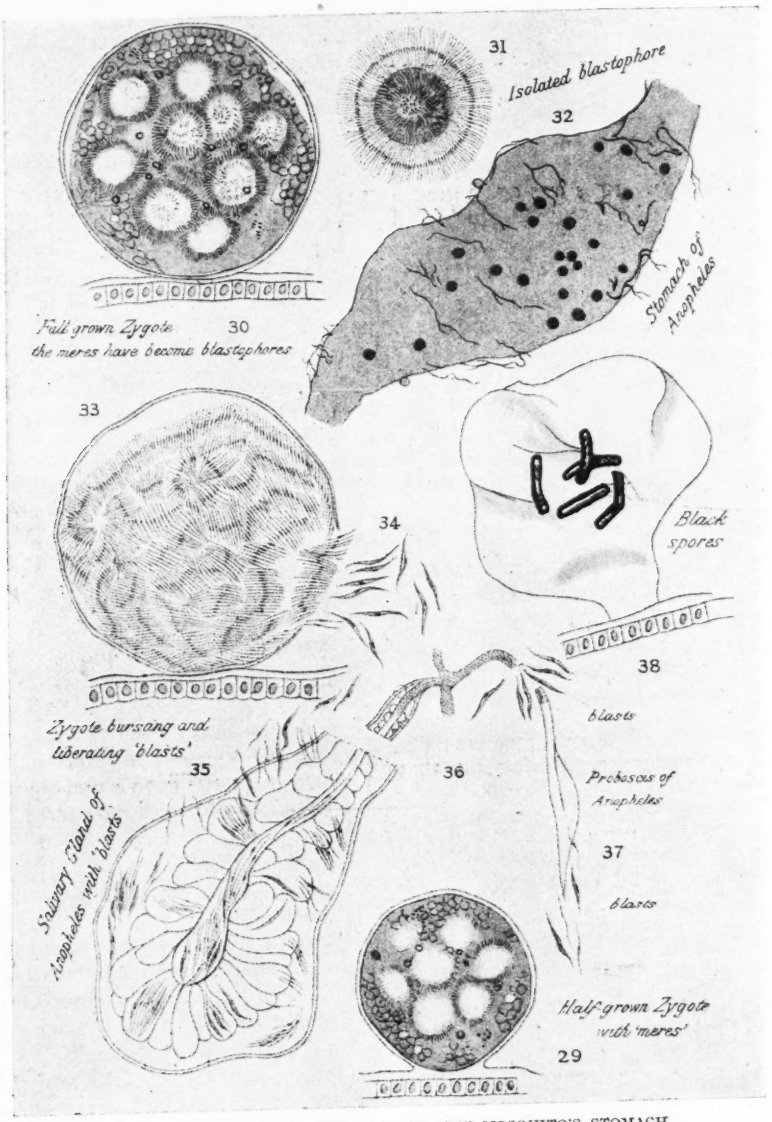

FIG. 2.—THE MALARIAL PARASITE IN THE MOSQUITO'S STOMACH

glands, of which he gives a very convincing sketch. He now had definitely established that malaria is conveyed from a diseased person or bird to a healthy one, and by the proper species of mosquito and no other.

He had solved the great problem.

On July 10th, 1896, he wrote: "I would better your suggestion that malaria is in the first place a disease of mosquitoes—hence the idea of its being carried by winds. It is the *mosquito* and not the *germs* which are carried by the wind." At that time he thought the germs were probably deposited in drinking-water, which thus became infective. Ross was again gradually making progress when he was suddenly moved from Secunderabad to Bangalore. This was the first of three serious checks the Executive placed upon his work until they finally checked it altogether.

Official Opposition

In 1897 he himself suffered from a severe attack of malaria. During this time he returned to Secunderabad and here again Fate stepped in and he was ordered (although it was not his turn for active service) to the North-west Frontier. He was working out the fate of the pigmented cells he had found in the mosquito, and was rejoicing over further proofs of the theory when he was ordered to a non-malarious district.

> "No sooner had I found the 'treasure island' than I was driven away from it by an opposing gale. I saw the promised land, but was not allowed to enter it. Owing to no fault of mine, two long years were to elapse before I was to see again—in another continent—that wonderful revelation of human malaria in mosquitoes. During all that time my work was to be pirated by foreigners, and the same maladministration which now drove me into the wilderness was to force me finally out of India just when my discovery might have been of real help to swarming and dying millions."

It is just as well that Ronald Ross has recorded in his book the names of some at least of the executive officers who did so much towards the postponement of the investigation of the cause of the disease which was killing millions of patients every year.

Still, the work was progressing, and in 1898 Ross had traced the parasites into the salivary glands of the insect when he was suddenly ordered to Assam, and coupled with his instructions to work at malaria was the command that he should investigate the obscure disease of kala-azar. Ross now decided to leave India a sadly disillusioned man. India had indeed rejected him:

> "In those days when an officer had been placed on special duty for any purpose and his work was done, orders conveying the thanks of the Government which had employed him were generally issued as some record that his duty had been faithfully performed. I was not so fortunate, and from that day to this have never received any recognition, that I am aware of, from the Government of India or even from my old service. I have never been consulted even on my own subject by that Government or by the India Office; never placed on any committee connected with it, never asked officially for my advice; never received any Indian honour, honorary promotion, or reward. In 1912 I was advised to ask for one of the small 'good service pensions' which were then sometimes given; but science evidently did not count as such, and I was refused. Out of nearly fifty honours bestowed upon me by governments, universities, academies, and societies, only one has ever reached me from India.[1] Indian writers, from G. M. Giles downwards, have generally attributed my work to others; and, much worse than this, have obstinately opposed my methods for the reduction of malaria. In fact, they have never forgiven me—for what I cannot imagine. Probably it was but the sheer ineptitude of the unintellectuals who 'despise science'; but, if so, the question remains whether such barbarians are fit to rule so great an empire."

Other Claimants

As has been hinted, Ross's claim to priority had been challenged, especially by certain Italian men of science. The work was claimed by many as soon as they saw it published, though hitherto these many had repeatedly proved themselves wrong in their attributions of the cause of malaria. The chief claimant was a Roman professor who seems capable of claiming anything, for we have a pretty good summing-up of his career in the criticisms of a colleague and fellow-worker of his, and we can safely leave him at that. Anyone who wishes to be sure of the facts of the priority of Ross's discoveries should consult a paper by Professor Nuttall on this question in the *Q.J.M.S.*, No. CLXXV, N.S., May 1901. Professor Nuttall's analysis of the records, for which he quotes not only the year and month, but the day of the month, has been questioned and is fully accepted by Ross. Once having been shown the way, it was easy for the Italians to follow it. No one can truthfully deny the fact that Ross was blazing the trail whilst the others were groping aimlessly in the dense and obscure thicket. But once they found their way to the clear path, they claimed it as their own.

Ross now resigned from the Service. He was financially rather crippled. He and his family had been

[1] "The Bombay Memorial Prize Medal, Asiatic Society, Bengal, May 20, 1903. I was made Consulting Member, Advisory Board, Indian Research Fund, but think that I have only been once consulted by it."

obliged to spend £500, including steamship fares, in addition to his salary during his service in India. After eighteen years, the pension awarded him by the Government was £292 a year, and he was now offered a lectureship on Tropical Diseases at Liverpool at the princely salary of £250 per annum with a proportion of the students' fees. He accepted this post, gave up microscopy, and now developed most successfully his scheme for sanitation. He visited time after time malarious districts on the West Coast of Africa, Greece, Spain, Cyprus, Egypt, and elsewhere, and in each region did much for the health of the people.

He has indeed received certain Imperial awards, and he was also awarded the Nobel Prize for Medicine, but his work in the relief of suffering, in the abolition of a most weakening disease, and even of death, is at least comparable with that of Jenner, Pasteur, Lister, Bruce, Banting, and others. Some of these received a sum of money which placed them beyond anxiety.

As Ross said (writing of Reed, who fell a voluntary victim to yellow fever and so died, apprehensive as to the future of his wife and daughter):

> "If I were a millionaire, I should give my money not to institutions, academies, universities, but to men like Reed, in order to make them independent for life. Those who have actually won decisive scientific victories in the past, know best how to win similar victories in the future. But they must be guarded against the scientific middleman, the managing committee, and the educational company-promoters, who are often to-day the parasites and exploiters of talent. They should be free to work where and how they will."

This is a long book, but not too long. It is pleasantly written, and although there are passages here and there one regrets, yet one must make all allowances for a man who has spent a third of his life in the tropics, often in malarial regions. Ross had exhausted himself in fighting official inertia and in defending the priority of his world-important researches. He knew, more than anyone, the value of his discoveries to suffering humanity, and he has been embittered by the fact that so little help has been afforded him in clearing up the malarial regions of this earth.

The Peopling of the Pacific

By A. C. Haddon, M.A., D.Sc., F.R.S.

THE glamour of the Pacific has permeated literature, both imaginative and scientific, and with increasing knowledge we can but echo the famous saying of the Queen of Sheba, "For even the half has not yet been told."

The object of this exposition is to indicate the modern aspects of the problem of the migration of men into this area. The first part is devoted to a general account of the movements of peoples, their salient physical characters, and a few of their cultural features. The second part deals succinctly with the cultural history of the Indo-Pacific area; this is mainly an exposition of the thesis recently promulgated by Mr. W. J. Perry, and an indication of some of the difficulties which have to be resolved before the theory can be thoroughly established.

Migrations into the Pacific

All the living representatives of the oldest known peoples in the southern part of the Old World are dark-skinned, woolly-haired folk, usually with long narrow heads, always with broad noses, and often with projecting jaws.

There are two main varieties of this stock, one of pygmy stature, the other taller; both of these varieties are found in Africa and in the Indo-Pacific area. In South Africa, the yellowish-skinned, short, but not pygmy, Bushman is an aberrant variety.

Examples of the Eastern pygmy, or Negrito, group are found in the Andaman Islands, in the Malay Peninsula (Semang), in the Philippine Islands, in New Guinea, and traces of them are found in Melanesia.

The taller variety of this stock which occurs in New Guinea is usually designated by the general term of "Papuan," but the greater part of the interior of New Guinea is occupied by short folk; whether they are an intermediate stock between Negritos and the taller Papuans, or whether they are due to intermixture, has yet to be decided. There seems to be a considerable range of variation in the head-form of the Papuans, though how far this is due to admixture has yet to be determined.

The now extinct Tasmanians were a distinct variety of this woolly-haired group, though with somewhat broader heads. They are said to be more uniform in type than the Australians or Papuans. The Tasmanians were a people of very low culture, some of their stone implements resembled those of the Middle Palæolithic period of Europe. Unfortunately, practically nothing is known about their social life, customs, and beliefs. Professor Sir Edgeworth David has recently stated that an implement has been found in a deposit belonging to the last Glacial period of Tasmania. This places the migration of the woolly-haired folk very far back, perhaps to about 20,000 years ago. There is no doubt that the last of several earlier land connections between Australia and Tasmania was then

open, so these people could have walked almost, if not all, the whole distance from their original home in Asia, by way of the East Indian Archipelago, for that region of closely situated large and small islands is part of the volcanic and earthquake zone that girdles the Pacific, and such regions are peculiarly liable to changes of level. Therefore there need be no difficulty in assuming land-bridges at various times by which man could have crossed from the Continent of Asia to that of Australia ; at most there may have been one or two narrow straits to cross. The only real objection to this view is that we have not at present sufficient evidence of the former occurrence in Australia of the ancestors of the Tasmanians.

At all events we are justified in assuming that New Guinea and the neighbouring islands, and the great chain of islands from the Admiralties to Fiji and New Caledonia, were inhabited primitively by dark-skinned, woolly-haired peoples of very low culture, who probably were mere collectors of food and were ignorant of the craft of tilling the soil.

The next type of man that entered Australia belonged to what is now generally spoken of as the Pre-Dravidian race. In Asia this race is represented by the Vedda of Ceylon and various jungle tribes of South India, and by the Sakai of the southern portion of the Malay Peninsula, and traces of it have been found in Indonesia, and some assert also in New Guinea. The Talgai skull, which was found in New South Wales, seems to belong to this race and may be termed " Proto-Australian " ; it has very large canine teeth. A somewhat similar skull has been found in Java. The fossil Talgai skull appears to have been contemporary with some marsupials that are now extinct, so that the advent of the ancestors of the Australians must be placed very far back in time.

The Australian has a dark chocolate-coloured skin, a long narrow head, broad nose, and projecting jaws ; but his hair is curly or wavy and very different from that of the earlier woolly-haired peoples. He is merely a collector and not a producer of food. The Australians overran the continent and, as they are now fairly homogeneous in their physical characters, they must have exterminated or absorbed any people who may have preceded them.

Since this time there has been no distinct racial migration into Australia ; doubtless outside cultures have penetrated into the country, but these were brought by too few people to have had any serious effect in modifying the Australian physical type.

Later Migrations

Very much later a series of migrations spread in a south-easterly direction from the East Indian Archipelago. The first of these migrations brought a higher culture, for the migrants were tillers of the soil, and a new type of language—the Austronesian. Languages of this type, and members of the same Austric linguistic family, are spoken in Chota Nagpur and elsewhere in northern India, but they have no genetic relation whatever with the Dravidian or Aryan languages. Austric languages are spoken by the Khasi of Assam and are spread all over Further India and throughout Indonesia (the East Indian Archipelago). We therefore are justified in supposing that the original speakers of the Indonesian languages came directly from the mainland of Indo-China, where the roots of the words still survive as actual words in everyday use. It is possible that the Austric family of languages arose in the valley of the Ganges.

Perhaps the earlier of the light-brown, Austric-speaking inhabitants of the East Indian Archipelago were a narrow-headed people, with wavy hair and a moderately narrow nose, who have been termed " Indonesians " ; these seem to have been followed somewhat later by a broad-headed people, the Proto-Malays. At all events, even now, these two types can be distinguished, though great mixture has taken place. These wavy- or straight-haired peoples were seafarers and probably very early had invented the outrigger for their canoes.

They voyaged to the western Pacific and found there before them the dark, broad-nosed, woolly-haired people with whom they mixed. Thus were formed the peoples we term " Melanesians," some of whom are lighter in colour than the Papuans, though most are as dark or even darker, and also we frequently find that the hair may vary from woolly to curly and wavy, and often the nose is of medium breadth ; but subsequent immigrations of the same group of peoples from Indonesia have increased this departure from the original Papuan type. The language of the early new-comers supplanted that of the original inhabitants, but in doing so was locally modified in various ways by the languages of the indigenous Papuans.

It may here be noted that the languages now spoken in the west, centre, and indeed throughout the greater part of New Guinea belong to a different linguistic family from that of the Austric and Australian languages. As a matter of fact, they form a congeries of languages, the affinities of which among themselves or with other linguistic families are at present obscure. This does not apply to various coastal areas, which may extend a short distance inland, where immigrants from Melanesia have brought to New Guinea certain Melanesian cultures and languages.

Other migrations, according to Dr. Rivers, followed from the East Indian Archipelago. The earlier of the peoples of these later migrations drank kava (a drink made by chewing the root of the pepper tree) ; these,

presumably, were yet more civilised than their forerunners, but they spoke the same type of language. These kava-drinkers adventured out into the Pacific and formed the basis of the Polynesians.

Perhaps the last main migration from Indonesia brought the people who chewed the betel-nut, and the influence of these " Betel People," as Dr. Rivers (1914) terms them, extended down Melanesia as far as the Santa Cruz group, but they did not enter Polynesia.

The Polynesians

There are various types of Polynesians; some are narrow-headed, others broad-headed. There is, however, as yet too little information concerning their physical characters to speak with any definiteness about them, indeed the same applies to the inhabitants of Melanesia and New Guinea.

Professor Roland B. Dixon definitely accepts a mixed origin for the Polynesians, and says: " The fundamental facts upon which the explanation of the racial history of Polynesia must rest are: (1) The dominant position held by the Palæ-Alpine type in the Hawaiian group; (2) the concentration of the Proto-Negroid type in Easter Island and the whole south-eastern portion of the area; and (3) the preponderance of the Alpine type at the present time in western Polynesia and among the population of New Zealand prior to the fourteenth century. The first people to enter and settle in Polynesia were, I believe, a mixed ' Melanesian ' folk, primarily dolichocephalic, a blend of the Proto-Negroid and Proto-Australoid, with a dash of the Caspian type " (p. 384). Later, by way of Micronesia, arrived new-comers, probably few in numbers, who were " in the main of Caspian type, but with minorities of other dolichocephalic forms.... Like their predecessors, they did not win north to Hawaii or south to New Zealand " (p. 385). The third and last period of migration brought again a new type which was in the main Alpine, probably through Micronesia. Professor Dixon regards these as the " Polynesian ancestors " of tradition. This is not the place to discuss the views of Professor Dixon, but we may agree with him in the complexity of this particular problem.

Quite recently Mr. L. R. Sullivan has recognised " at least two basic elements " among the Polynesians: " Type A, which may be considered Polynesian proper, is a Caucasoid element with physical characteristics intermediate between some Caucasians and some Mongols. It may prove to be a very primitive Caucasian type related to the earliest inhabitants of Micronesia, Indonesia, and to the Ainu of Japan, and to some primitive Americans. It is probably the oldest type in central and eastern Pacific and occupied all the Polynesian islands. At present it is strongest in southern Polynesia." It is of tall stature, has a moderately long head, a very high but very broad nose, straight or wavy black hair, a light-brown skin, etc.

" Type B is the Indonesian element typically developed in the region of the Celebes. It is a Mongoloid type, but unlike the Malay, is strongly divergent in the direction of the negro.... Type B is strongest in northern and central Polynesia." It has a shorter stature, shorter head, a very low and very broad nose, wavier hair, a darker-brown skin, etc.

" Type A, Polynesian, and Type B, Indonesian, are not closely related in a physical sense. The Indonesian is the antithesis of the Polynesian in nearly every detail.

" Hybrids of Type A and Type B are much more Mongoloid in appearance than is either of the parental types."

By " Caucasian " Mr. Sullivan evidently means a relatively narrow-headed, European-like type, but I cannot agree to this use of the term nor with his identifications of it elsewhere. It is unfortunate also that he has adopted the term " Indonesian " for a broad-headed type, as the name Indonesian has now become generally adopted for the narrow-headed element in the population of Indonesia.

" From the frequency and distribution of these two quite distinct physical types in Polynesia it is clear that they must have entered the Pacific at different times, and possibly by different routes. Certainly they must have had different languages and cultures. The Polynesians are to be found in all parts of Polynesia. The Indonesians are not at present to be found in all parts of Polynesia, nor indeed in all parts of the island groups in which they occur." Mr. Sullivan leaves it an open question which of these two groups arrived first in Polynesia.

In addition to these two types, there is a Melanesian element in certain parts of Polynesia; this is naturally strongest in the south and west.

" A third element in the Polynesian population is characterised by extremely short heads (which is due to some extent to artificial deformation), narrow faces, narrow noses, light skin, and well-developed beard and body hair. Representatives of this element have not been found in Polynesia in sufficient numbers to justify specific description. When studied in a region where it is well represented, this element may prove of sufficient importance to be recognised as Type C. This element has probably contributed some of the Caucasoid traits to Polynesians." Mr. Sullivan says: " It is to this element of the Polynesian population that Professor G. Elliot Smith has referred as ' Proto-Armenoid,' " and the latter believes that these " Maritime Armenoids " were the carriers of culture to

Oceania and elsewhere. Professor Elliot Smith states that what he terms "Giza traits," which he derives from "Armenoids," have a "widespread distribution . . . not only in Polynesia, but also in the Malay Archipelago and at certain places on the southern Asiatic littoral . . . the same distinctive traits were by no means rare on the Pacific coast of Central and South America." The distribution, as given by him, of this type on the mainland of Asia does not concern us at present.

It is evident from this brief sketch of human wanderings to and in Oceania that unsolved problems await further investigation by physical anthropologists.

New Light on the Ruins of Troy

By Stanley Casson, M.A.

Fellow of New College, Oxford

THE ruins of Troy rise at the end of a bluff that projects on to the Trojan plain like a headland on a sea. This has given the amateur geologist his chance, and it was long ago suggested that Troy was, in the great days of its history, a coast town. But the mightiest efforts of the Simoeis and Skamander to deposit a shore line in advance of the old bluff would be infinitesimal over a long course of centuries as long as the swift current of the Dardanelles, that runs at three miles an hour near Troy, can sweep all sediment from the rivers far out into the Ægean.

Troy stood on its bluff because the spot where it stands both commands the plain and overlooks from a height the traffic of the straits and the approach of ships from the west. Troy is still to-day the only clear landmark for observers on Cape Helles, and when the Trojan plain was below the horizon sailors from Imbros, Samothrace, and the Thracian coast could see its towers even as now they can see its not insignificant mound.

Dr. Walter Leaf has well shown how Troy fulfilled several functions. All trade routes converged at its gates from north-west, from north, from east, and from south. It was the clearing-house of the trade of the Euxine and the Asiatic hinterland. It was in the plain of Troy below its citadel that the caravans of the East met and traded with the merchants from the West. But most important of all—Troy closed the Dardanelles; it served the purpose of a combined Constantinople and Dardanelles fort; it is as if the old Byzantium had been built with Kum Kaleh just in front of it, to trade and guard at once, and with the Seddul Bahr forts to keep its flanks. The British landings at Cape Helles would, in this case, have been a more accurate parallel to the Greek landing before Troy.

There seems little to invalidate Dr. Leaf's theories. They have, in fact, achieved almost general acceptance. Their merit is that they provide a *sufficient* explanation of the problems they set out to explain. The only important rival theories in the field, those of M. Bérard, are insufficient explanations. Bérard, by enunciating what he called "the law of the isthmus," explained the wealth and importance of the city of Troy in antiquity by its geographical position, even as Dr. Leaf does. But to Bérard Troy was merely a fortress in the Troad: to Leaf it is the port of Asia on the Ægean. Bérard accounts for the legendary wealth, which Schliemann proved to be an actual wealth, of Troy by the theory that it levied toll on all the trade that crossed the isthmus from the straits to the Ægean or from the Ægean to the straits. Trade had to make such a crossing because the currents that run out from the straits sweep traffic from the east away out into the Ægean or round by Tenedos if it attempts to pass the Cape of Sigeum at the point of the Troad; similarly they prevent the entry of traffic from the west. Wise sailors, then, landed their cargoes on the shore due north of Troy if they came from the east, and sent them by pack transport past Troy to the other sea, re-embarking at a point west of Troy. If they came from the west, they re-embarked again inside the straits.

But this is not reason enough. It would explain a small fort or settlement, but it does not account for the great international trading centre that excavation has proved Troy to have been. It is a good explanation of the first settlement at Troy, but not of the second and the sixth. Besides, as Leaf showed, Bérard's data are inadequate. It is true enough that sailing ships can only with the greatest difficulty round the Trojan cape from east or south-west. But from the north and north-west it is no great matter. The mass of Imbros and Samothrace heads off the main force of the current and drives it south-west. Ships can coast round Cape Helles after using the waters of the north side of the peninsula, which have no current that runs against them. Besides, the prevailing winds are from the north and north-east.

Troy, as Leaf says, held the straits: "The possession of Troy must have given power to close the Hellespont absolutely against the merchant adventurer from the West. Thus shut out from the markets of the Black Sea, the Greek had no choice but to trade with them (the owners of Troy) under the walls of Troy itself" (p. 264).

The "Tomb of Protesilaos"

Troy also held the other shore, he suggests. Here his view is borne out by recent discovery. The so-called "Tomb of Protesilaos," the modern Karagatch Tepeh, on the European side of the strait is of the same type as those which are found in the Troad around Troy itself. It so happens that this so-called "tomb" has played a prominent part in the recent war. It lay just inside our line after the British forces had reached their maximum advance in 1915. It suffered all that so prominent a tactical feature might be expected to suffer, and its sides are deeply scarred with trenches and dugouts. Lately it has been cut into by French troops. From the soil so uncovered it is possible to reconstruct a little of its history. Stone axes and pottery show that the mound is a habitation-site of exactly the same date and culture as the first settlement at Troy—that is to say, about 2900 B.C. It belongs to the period of transition between the Stone Age and the age of metals. Copper is found both in Troy I and at this mound. Green jade axes are also found on both sites.

In some sense, too, the "Tomb of Protesilaos" is a fortress. It lies midway between the two shores of the peninsula, which hereabouts is a flat-surfaced promontory rising gently upwards to Achi Baba. But it lies in a slight depression at a point where several streamlets meet and form a marsh. The mound is in the middle of this marsh, thus deriving the full advantages of local defence. Forces landed at either shore could reach it in twenty minutes, and it could not run the risk of a surprise which it would run if undefended. It was, thus, a true fortress. Leaf's suggestion that at this mound was a strong outpost is entirely verified.

But caution is needed. Leaf's theories cover the whole period of Trojan history before it finally fell. The "Tomb of Protesilaos," however, has produced nothing of a date later than Troy I except for certain Greek or Roman foundations on its edge, that probably indicate that the ancients held it in reverence as a tomb and built a shrine on it, ignorant of the fact that it was really a settlement mound and not a burial mound. As a sister settlement to Troy I it thus is the ancestor of Seddul Bahr fort, even as Troy is the ancestor of Kum Kaleh. But the great second city of Troy seems to have been powerful enough to dispense with the fortress on the European side. Its work was done. The first Troy was a mere village, and the companion site near Cape Helles enabled her to get her first grip on the straits. So round Troy itself there were other sites founded by the same settlers.

To all the mounds that rise on the Troad the Greeks

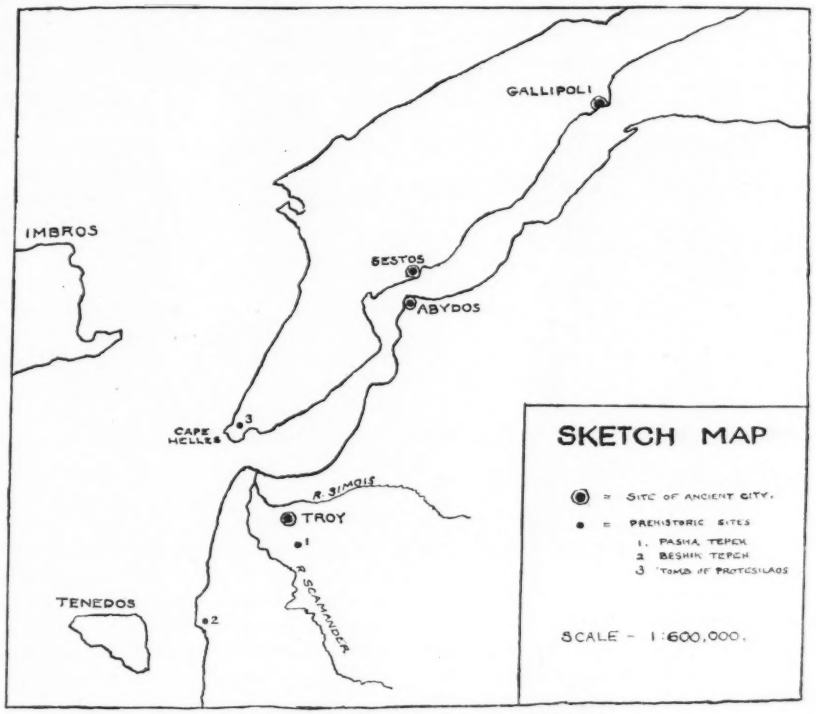

FIG. 1.—SKETCH MAP SHOWING SITES OF TROY.

and Romans gave names that transformed them into tombs of Homeric warriors. Most of them have been identified, as has the "Tomb of Protesilaos,"[1] from passages in ancient authors. Nearly all of these mounds have been excavated, partly by Schliemann and partly by amateurs. The results are disappointing. Some prove to be natural, simulating in outline the burial or settlement mound. The following is a list:

Name of Mound.	Excavated.	Ancient Sources.
1. "Tomb of Ajax" (modern In Tepeh).	By Schliemann. Only Roman remains found.	Pausanias, i. 35, 3.
2. "Tomb of Achilles" (at Scamander mouth).	In 1786; records unreliable. Probably a fifth-century tomb.	Pliny, *Nat. Hist.*, v. 33.
3. "Tomb of Priam."	By Mr. Calvert. Proves to be of classical period.	
4. "Tomb of Patroclus" (at Scamander mouth).	By Mr. Calvert. Nothing found.	Iliad, xxiii. 125.
5. "Tomb of Hector."	By Sir J. Lubbock. Probably artificial; nothing found.	*Dio Chrysostom*, Orat. XI. 179. Iliad, xxiv. 792–801.
6. "Tomb of Æsyetes" (modern Pasha Tepeh).	By Mrs. Schliemann. Habitation-site of period of Troy II.	Strabo, xiii. 599.
7. Modern Ujek Tepeh (east of Beshika Tepeh).	By Schliemann. Probably a habitation-site, but record imperfect.	
8. Modern Beshika Tepeh (at Beshika Bay).	By Schliemann. A habitation-site of period of Troy II.	
9. "Tomb of Ilus" (near Kum Keui village).	By Schliemann. A natural mound.	Iliad, x. 415, xi. 371, etc.

To these mounds must be added another that belongs to the European shore. It is the modern Mal Tepeh above the Kilia Valley and on its eastern side. It is probably a burial mound of the classical period to the neighbouring Greek town of Madytos. It may correspond with the so-called "Tomb of Hecuba" mentioned by Strabo[2] as being on the Thracian Chersonese directly opposite the River Rhodios, between Dardanos and Abydos. It was also known as the Kynossema. Of all these tombs, then, Pasha Tepeh and Beshika Tepeh in the Troad alone seem to be of importance. They, together with Troy I and the "Tomb of Protesilaos," form a little group of sites belonging to the first settlers at the entrance of the straits. The general affinities of this culture are with the north, with Thrace and the Danubian regions. It is significant that there are no other sites of the same period on the European shore, between Cape Helles and the town of Gallipoli. As far as is known there is none recorded on the Asiatic shore over the same area. The importance of the twin promontories at the mouth of the straits seems to have struck these earliest pioneers. For the coasts of Marmora, unfortunately, no observations or records are available. At the western entrance to the Bosporus, however, another site of the same date and type is recorded opposite Stamboul, near the site of the ancient Chalcedon. Again the importance of the straits seems to have been realised at this early period.

In view of the recent history of these regions, the development in the Chalcolithic period of an idea of the value and importance of the straits is not without interest. More important, perhaps, is the light it throws upon the history of Troy itself.

Troy II—a Flourishing Port

The archæological records of the second city at Troy show Dr. Leaf's "Oriental Emporium" in full vigour. The variety of imports is astonishing. The famous four ceremonial axes are a marvel of expert stonecraft. Although this was a period of metal, the workmanship of the axes betokens a development of the technique of the Stone Age. The knobs with which the sides of the axes are decorated are cut with a hollow boring-reed which drills, by the aid of sand, a circle the centre of which is then worked up into a knob. The manufacture must have been as old-fashioned as the ceremonial for which these axes were used. Of the four, two are of dark-green jadeite or nephrite, one of vivid-green jadeite, and the fourth of lapis lazuli. Both these materials must have been imported from afar, the jadeite probably from Switzerland, which is the nearest place of origin, and which seems more probable than Asia, in view of the general northern relations of Trojan culture. The lapis lazuli may come from Russia, and it is significant that two similar axes of hard stone, which are very close parallels, have been found near the River Berezina.

Of other materials, there is obsidian from both Melos and from Central Europe, and a third variety that may hail from Armenia; there is faience that can only come from Egypt or Crete; numerous earrings of gold that might have been made in the plains of Hungary, and rare beads of amber that hail either from Sicily or from the far north. But there is little that comes from the East.

All such things are eloquent testimony to the view that Troy was an international market as soon as ever it began to function as the guardian of the straits. But Troy II ends in flame. The well-girt city is sacked and burned. Its strong walls proved no protection. The tiles of its roofs are found in the debris vitrified by the heat of the conflagration. This was the first sack of Troy.

[1] Strabo, 331; 52 and 595.

[2] xiii. 595.

Troy VI—a City of Renewed Splendour

Then came a period of reoccupation and slow rebuilding by people of the same stock, culminating in the building of a new city wall greater than the first. This began in the time of the fifth city of Troy, the third and fourth being little more than periods of reconstruction. The next period, which is known as Troy VI, saw the completion of the new girdle walls and of a renewed splendour of the city.

This new Troy is frequently referred to as Mycenæan Troy. This is a misnomer. The city is contemporary with the last phase of Mycenæan culture and there are innumerable traces of Mycenæan culture in its soil. But the predominant elements of Trojan culture at this time are essentially native. The same old technique and designs that have developed in Trojan pottery from the earliest foundations still persist and are predominant. Mycenæan pottery is clearly imported, but so popular is it that local imitations at once appear. Still Troy is an independent city, and apparently so valuable a market that Mycenæan potters were prepared to make wares solely for Trojan use. Thus there is an example of the typical Trojan two-handled wine-cup, but made of Mycenæan ware and decorated in glaze paint, of a type that the Trojan never used. It was made on the mainland of Greece, probably at Mycenæ. Then there is a small figure of a pig decorated with Mycenæan glaze paint, that must also have been destined for the Trojan market.

But in other matters the native culture is predominant. The architecture is wholly un-Mycenæan. The city walls in no way resemble those of the Mycenæan fortresses of Greece. They are built of well-cut squared stones and not of the rough polygonal blocks, with the interstices filled up with smalled pieces, that are so characteristic of Mycenæ, Tiryns, and the mainland sites. As far as any affinities can be found for this masonry it is with Egypt. Dörpfeld was at once struck with this fact. On the other hand, features of the masonry such as the "batter" of the ramparts cannot be paralleled elsewhere. Another peculiarity is that the houses within the ramparts come right up to the city walls and are actually built on so as to join up with them. In both Mycenæan and Hellenic cities there is always a passage-way left between the city walls and the private houses: in Hellenic time it was enforced by law, the reason being that the building of houses close to the walls might give scope to treachery: the walls might be secretly breached or sapped. Troy does not appear to have considered these risks.

FIG. 2.—THE WALLS OF TROY.
To the left are the walls of the sixth century; to the right, Roman additions.

Whatever was the nature of this sixth city of Troy, its splendour is not so clearly recorded as is that of the second city. Troy VI seems to have been completely sacked and burned and with more thoroughness than Troy II. No treasures were found in the sixth city.

After the sack comes a pause. The site is reoccupied just as it was after the sack of Troy II. It is again slowly reconstructed by people probably of the same stock. The same objects of use appear as before. But suddenly, after a few years of this occupation, comes a complete change of ownership. The pottery suddenly becomes Central European, not imported but made on the spot. Danubian axes and other weapons appear. Some northern tribes have appeared from Thrace. Troy seems thus to have suffered much the same fate as Mycenæ and Tiryns and at approxi-

mately the same date. Above this Central European stratum, and to a certain extent in it, is found the simplest and earliest so-called "Geometric" wares of the Greek mainland and the islands. Again it is the same phenomenon as at Mycenæ and in the Argolid in general. But in the latter sites there was no Danubian stratum as at Troy. The flames that destroyed Mycenæ were, without doubt, the result of the sack of the town by northern invaders: but these invaders

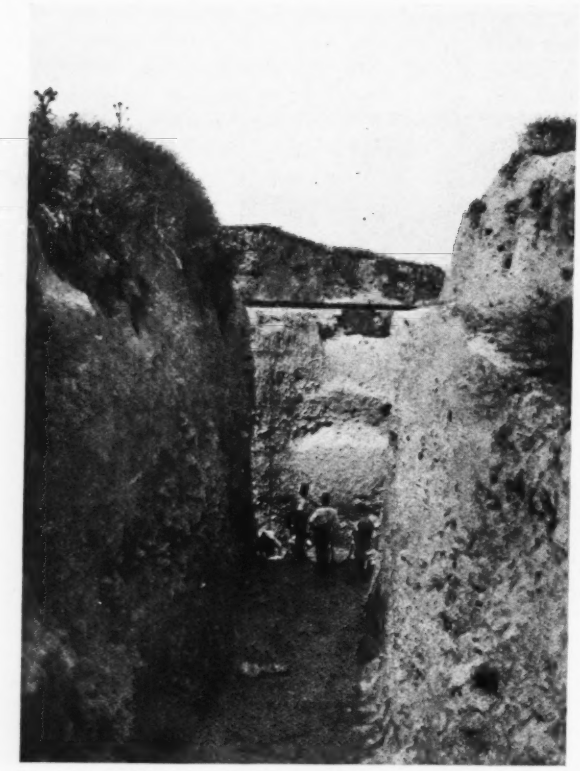

FIG. 3.—A CUTTING THROUGH THE "TOMB OF PROTESILAOS." The whole depth of earth is artificial deposit.

were not from the same regions as those from which came the men who sacked Troy.

The Legend of the Sack of Troy

The destruction of Troy as recorded by legend and by archæology involves many difficult problems that have not yet been solved. The records of legend are simple. Troy was destroyed in the year 1185 B.C. by Greeks from the mainland. But archæology shows us two destructions of Troy of an importance sufficient to account for the legend. The first is that which Troy II suffered about the year 2000 B.C. The second is the burning and demolition of Troy VI about the end of the thirteenth century B.C. The former is the destruction of a strong and wealthy town which, as the discovery of the so-called "Treasure of Priam" showed, was one of the leading cities in the Ægean in wealth and magnificence. The latter is the destruction of a larger and still more important fortress whose inhabitants were in close touch commercially with the opposite shores of the Ægean. The chronology of the two destructions is clear. That of Troy II can be fixed by the character and types of the jewellery as well as by anything else, and these belong to the full Bronze Age. That of Troy VI is fixed indisputably by the imported Mycenæan pottery found in its ruins.

At first glance legend is abundantly confirmed by archæology. It is the destruction of Troy VI that corresponds exactly in date with the destruction by the Achæans of Homeric Troy. So the majority of historians accept it to-day.

But all is not so simple as it seems. Troy II still remains a city that could correspond in every detail with the Troy of Homer. Schliemann, who failed to detect the sixth city, was convinced that Troy II was the Homeric Troy. It was left to Dörpfeld, who completed the excavation, to establish the claims of Troy VI. But while we cannot say who were the destroyers of the second city,[1] we yet have no more clear idea as to who destroyed the sixth. After the demolition of Troy VI there is a period of reoccupation by people apparently of the same race. A new element does not properly appear until the period known as Troy VII B, which begins somewhere about the year 1000. And this new element by no means corresponds with what we can call either "Achæan" or Greek. The city is occupied by a more or less savage race from the Danube basin, who have been identified either with Thracians or with Cimmerians. If it was the Mycenæns who destroyed Troy VI, then they destroyed what was one of their best markets without enjoying the reward of their efforts. After its destruction Troy VI does not reappear as a great Mycenæan fortress, and the straits that it had closed do not admit the commerce of the Mycenæan empire to the Euxine. There are, further, serious objections to the equation of Mycenæans and Achæans.

With Troy II we meet the same difficulties. The destroyers left the city in ruins and departed. There is no imposition of a new culture, and it is left to the remnants of the Trojans to rebuild their ruined power.

What, then, of the Homeric story? It were wiser, I think, to avoid the temptation of fitting the legends exactly into the reconstructed history. All that archæology entitles us to say is that Troy was destroyed twice; that on each occasion the city had reached the

[1] Mr. H. J. E. Peake has a most suggestive article on this problem in vol. xlvi of the *Journal of the Anthropological Institute* (1916).

summit of its power and wealth; that the destroyers either came from without and then departed, or else that the destruction was the result of internal revolt. All that legend records is a great expedition that came from the mainland of Greece and after long struggles laid the great fortress in the dust. The date usually assigned to this event is the beginning of the twelfth century B.C. The earliest legends of all record a destruction of Troy by Herakles in the time of Laomedon, first King of Troy. There may be preserved in this story some recollection of the fate of Troy II.

But legend and fact obviously do not fit.

Compromise is always unsatisfactory, but in this case it seems inevitable. Legend is seldom homogeneous. What are apparently single stories are often a hotch-potch of varying tradition that comes from different ages. The Troy of Priam may well have been the Troy of 2000 B.C. in its material setting. The wealth and glory of the days of a great king are evident in the second city. But the story of the fate of that foundation may well have been eclipsed by the more complete and more terrible fate of the later Troy—Troy VI. Legend always assimilates the latest event, and in the stories that were sung in the ninth century the fate of Troy in the twelfth bulked so large as to dwarf the earlier catastrophe. But elements of the life and of the setting of the older city of many centuries before, and individual legends of single events, had survived, just as the British King Arthur and his court survived into a mediæval setting. Then, again, still later occupations of Troy have left their mark. None of the settlers can be unreservedly called Greeks until the time, in the tenth or ninth century, when the Trojans were in touch with, or had been colonised by, a people who had made the "Geometric" wares of the last strata. These same people are found on nearly every Mycenæan site on the mainland of Greece immediately after its final destruction; but at Troy they were not first on the field. Yet they are the first definite Greeks who arrived there, and some of their more recent experiences may have worked their way into the Homeric legends.

Schliemann's instinct, then, was not so very far wrong. He saw the similarities between the earlier Troy and the material setting of the Homeric drama. Dörpfeld fell into the same error as Schliemann when he tried to equate the Homeric Troy with the last great city that he found. Trojan legend, like Troy itself, is, after all, a series of accretions of different periods. But whether it was one man who moulded these different legends into one or whether it was the work of several hands is a problem that the archæologist must confess is outside his sphere.

To read Trojan history and legend in the terms of Archæology may seem to reduce their living splendour to dry bones and dust. The archæologist must not overreach himself; the historian must remember that early history is not the mere action and reaction of dull geographical or economic principles. The human element is always predominant. Why should we not believe that the capture of Helen brought about the great expedition? No doubt there was many a profiteer who saw that he would make his fortune out of the war, but the capture of Helen may well have been the starting-point. After all it was the restoration of a pretender that brought about the capture of Constantinople by the Crusaders of the Fourth Crusade. Henry Dandolo, it is true, the sinister promoter of the scheme, had a very good idea of the economic results that would accrue to Venice. But the economic laws were scarcely more evident than this, and it would be rash to say that the capture of the city was due to the inexorable working of an economic law. We need not excise all the romance from the old stories of the stormers of cities.

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Railway Development as a National and International Function

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THERE is a sense in which Europe stands on one side of the world's arena and all the rest of the world stands on the other. Smaller than all except one of the continents, Europe and European history have shown, for good or for evil, more of a dynamic quality than the other continents, or at any rate than they have shown as yet.

The distinction indicated is realised to some extent by the peoples of Europe themselves. A realisation of it lies behind much of the emigration that occurs; and our conceptions of "colonies" and "colonial life," and now, to some extent, of Dominion status and Dominion life, also imply a consciousness of it.

But perhaps more conscious of it are the peoples outside Europe, especially those of North America and Australia. On these young peoples, when they look back, Europe and European civilisation, the fountain-head of their own, exercises a fascination and yet a curious repulsion. Something in their experience—dim and deep-rooted in the past—bids them beware. While the prevalence and potency of this feeling may easily be exaggerated, it may also be unduly minimised. Its positive as well as its negative limits are discernible in affairs to-day.

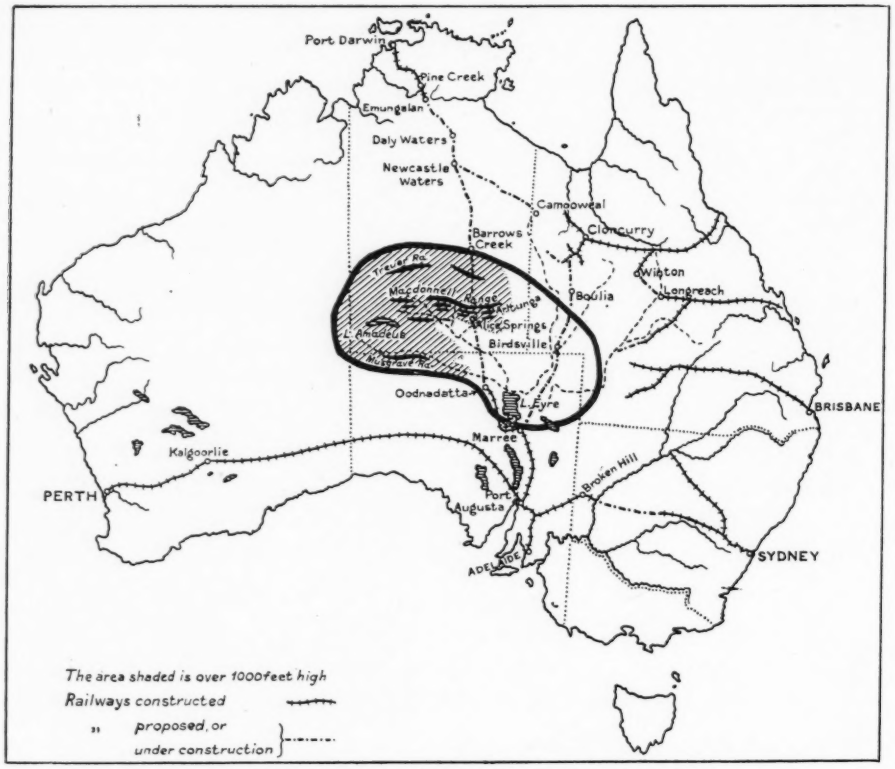

FIG. 1.—CENTRAL AUSTRALIA (MARKED WITH THE HEAVY LINE).

There are reasons for this feeling, which it is the business partly of the geographer to elucidate. The following observations attempt no scientific analysis of this human phenomenon; they merely indicate one or two of the more obvious reasons and call attention to one—though a pregnant—form of human social activity which gives to the distinction mentioned somewhat unexpected and striking expression. We refer to railway development.

That this should be so is no accident. Railways, after all—not single lines so much as whole systems—are epitomes of the human meaning of a region. They may be supplemented, or even superseded, by other systems of transport, but it is doubtful if they will ever lose their significance. That they typify the humanised as opposed to the purely physical landscape goes almost without saying. They also symbolise, in a degree not always realised, the corporate social and political mentality of peoples. They reveal their desires, their ambitions, their fears; they lay bare a people's needs and its weaknesses. They show where a people look for pleasure, profit, or power; they indicate, like a human nervous system laid open to view, the very springs of national sensitiveness, the springs of a nation's response to external and internal stimuli.

We must beware, however, of pulling the system to pieces, lest in dissecting we extinguish life. The moment we begin to analyse, to apply statistical tests, the truth that lives in the organic situation as a whole vanishes: we are left with a debris of irreconcilable and meaningless detail. In matters human, mathematical calculations are apt to mislead. The best impression of the human significance of railway systems and railway development is conveyed by maps, preferably maps made with some other main object in view.

Europe—an Area of Intense Individualisation

It is a commonplace that Europe is an area of intense individualisation. The vast and somewhat expressionless expanses of forest, swamp, and marsh—with a few bare plateaux and snowy spines—which constituted primeval Europe have been transformed by human agents. Diverse peoples through devious historical processes have gradually chiselled out the sharp human features latent in the raw geographical background. The full and rich individuality of the continent—a fullness and a richness hardly matched by any land-mass of similar size [1]—has been given form and expression. The intensely local, even parochial, traits of the landscape have been unearthed, cultivated, enjoyed. Anchored by the heart to a thousand various valleys, glens, basins, or intermont plains, or settled with perhaps inarticulate attachment upon some spot in rolling plain or sea- and wind-swept waste, the peoples of Europe developed loyalties, affections, boundaries of mind as intense, clear, varied, and as limited as the soil, climate, vegetation, and natural forms of their homes.

This has been mirrored in European history, with its multiplicity of States, its kaleidoscope of processes, its evanescent political systems—with its tendency continually to disintegrate, to gravitate back to localities, to revert to geographical and racial individualism.

The national States—with their semi-geographical basis which we see on the map of Europe to-day—are compromises. They are somewhat grudging concessions to that instinct towards higher social syntheses, more complex social organisms, to which human beings tardily respond. No doubt the stress of increasing population and the slow realisation of the superior comfort, efficiency, and power of larger organisations have gradually forced the doors of geographical particularisms and fostered synthetic processes.[2]

The coming of the industrial or mechanical era did a great deal to emphasise this tendency. It seems, indeed, to have over-stimulated the process and to have hardened prematurely the lines of national division. This was but a phase: it is the phase represented in the pre-war map of Europe. The same geographical forces which hardened those lines have, by their continuous operation, by the release of still deeper and subtler economic influences, acted—or seem to be acting—as solvents. The pre-war map of Europe represented a situation to some degree forced and artificial, where economic forces were cramped within unnatural confines. The years since 1914 have brought or are bringing liberation. By focusing human attention, and also human passion, upon impossible restrictions, the fundamental factors in the situation are shaping, through blood and travail, a new order. Looking back we can see now that Europe had to be born again.

[1] Vide M. I. Newbigin, *Frequented Ways*. Introduction.

[2] The reference here is, of course, to voluntary, self-imposed organisation, not to those forms of synthesis imposed by conquest. Empires and empire builders ignore geographical facts at their peril; democracies hardly exist except by virtue of them.

European Railway Systems

Now many of these things can be read on maps, and nowhere more clearly than in maps showing the pre-war railway systems. Many illustrations might be given: we must confine ourselves to two or three.

The border-zone between France and Germany, with its general parallelism of lines, to the pre-war political boundary and its corresponding paucity of

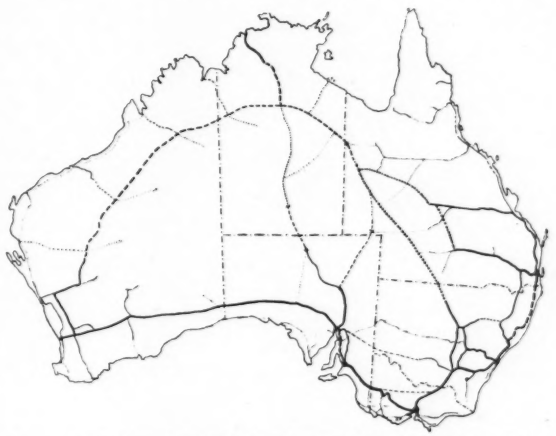

FIG. 2.—THE AUSTRALIAN RAILWAY SYSTEM OF THE FUTURE.

great main through-lines, such as might be expected to link two of the greatest and most enlightened nations of the world, is significant. The great drive of lines through and across Belgium and Holland, on the other hand, is noticeable, and so is the function of Switzerland as a common meeting-ground. It is, perhaps, hardly necessary to say that a very great number of other factors enter into the making of the situation represented: here only one is selected and emphasised.

The eastern border-region, again, of the pre-war German Empire shows, as is well known, a remarkably "nationalistic" railway development. Elements of the former system are now left protruding, like the ribs of a stranded vessel, into Poland.

The map of Hungary also illustrates—as might be expected from its geographical structure—a vigorous development upon national principles. This appears especially clearly if we study the historical growth of its

system. But it also illustrates how a smaller area, curiously accessible to a larger and more powerfully organised one, has been developed as an integral part of that larger economic and political system, namely, the Central European Block.

In 1913 Hungary rejoiced in twenty-eight frontier railway-stations; now she laments with fifty-one. Does this, or does it not, augur well for a possible United States of Europe?

Turning now to the world outside Europe, we may observe in passing a system of railways which in many respects symbolises a state of affairs the antithesis of what we have been observing. Here we have a different order of things, a different human response to different geographical and historical stimuli.

Superior Conditions for Railway Development in the Young Continents

Of the extra-European continents as compared with Europe, Asia represents one sort of contrast in the sense we are here concerned with; the great "new-lands" in course of penetration by Western civilisation—North America, Africa, Australia, and to a less degree South America—represents another.

From these we may select Australia as a singularly clear and, indeed, somewhat extreme and exceptional case of the other tendency which we shall now examine.

In Australia we have a geographical unity of a particularly clear-cut, self-contained kind, uniform in certain respects to the point of monotony. Geographical distinctions within the continent can and must be drawn, but they are of a large and simple nature. Here, therefore, is a considerable basis of unity.

The Europeans who settled in Australia were predominantly British, and that also made in the long-run for unity. At the same time they brought with them traditions of individualism and exclusiveness. Moreover, they settled around the island at points widely separated by stretches of inhospitable coast and of still more difficult interior. As development proceeded, there was consequently evolved and superimposed on the geographical unity a system of political boundaries mathematical and artificial to a degree. With one or two exceptions, the political boundaries within Australia are geographically meaningless. Their very logicality invites neglect. Nevertheless the political development of Australia proceeded along Old World lines.

Australia an Instance of this Fact

This is reflected in the growth of the Australian railway systems, which for long were mainly devoted to the service of local and State interests and to the development of purely State resources. Certainly the need for land communication between the eastern capitals was felt early, and these were finally linked by 1889. Moreover, the very shape and physical build of the continent determined almost from the beginning that railway development in the various States should show upon the map a certain similarity of ground-plan design, and this created a basis for later unity. Thus the main lines tended roughly to follow coastwise directions at some distance inland from port to port, and branching from these lines, and, to an increasing extent, based deliberately upon them, grew a system of lines striving inwards. This drew around and through the south-eastern coastlands a sort of extended arterial or trunk system, while at either end (in Queensland and Western Australia) grew isolated sprouts.

Still, in principle as in fact, in spite of the one great through-line and an increasing number of minor contact-points on State boundaries, development was by States and for States. It was not a system but a series of systems. The railway map of Australia (Fig. 1), and still more a map which shows the distribution of the different gauges, bears unmistakable witness to Australia's old particularist origins.

The creation of the Australian Commonwealth as a political system marked the growth of commonwealth feeling. By commonwealth feeling we mean a realisation that Australia is a geographical, economic, and human unity, and that for the good of all it must be developed as such. Steadily advancing during the course of this century and greatly accelerated and intensified by the experiences of war, this spirit has triumphed in principle and is now the tacit assumption, the unquestioned basis of Australian argument and discussion.

The transformation that is taking place under its influence is well illustrated in the case of Victoria. Here is a State which energetically developed a system of its own. Its very vigour led it on to larger things. It will be seen that Victoria and South Australia have effected a working arrangement, for their mutual advantage, by surrendering economically their north-western and south-eastern corners respectively each to the other.[1] Similarly New South Wales and Victoria have agreed that the area north of the River Murray must drain to its natural seaboard and that the somewhat artificial political boundary—in this case the Murray—shall for economic purposes be ignored.

What applies to Victoria applies to Australia as a whole. All major Australian railway projects are essentially commonwealth problems in that they involve the interests of more than one State. The

[1] The south-eastern corner of South Australia is richer than the north-eastern corner of Victoria, hence the disparity in size of the two areas. Also each State retains railway communication with its own territory.

present position has not been arrived at without long experience of inter-State particularism and exclusiveness, and a firm conviction of the futility of this spirit now accounts for the rapid progress being made along larger constructive lines.

We may now turn to the Commonwealth railway system as a whole. This system is still rudimentary, but its main outlines can be forecasted with tolerable certainty. It is not possible here to give the evidence upon which our conclusions are based.

Fig. 2 shows a skeleton of the probable future Commonwealth system. Continuous lines indicate existing, broken lines projected, railways or probable developments.

We see that there will be: (1) An outer or coastal ring, elements of which already exist. It is not, perhaps, likely that this ring will ever be quite closed. (2) An inner ring, parts of which exist while other parts are in contemplation or actually being negotiated.[1] (3) Sections of a radial system cutting across (1) and (2) and connecting hinterlands with their appropriate ports. (4) An overland north–south line, probably via Alice Springs. Cross-lines will connect this with the "inner circle" on the east. (5) One or more direct east–west lines connecting Western Australia by shorter routes with the eastern seaboard. Besides this there will naturally be a whole network of minor connections and adjustments.

What of the Future ?

Thus Australia will probably develop a railway system of peculiar symmetry, strength, and efficiency. Its construction will demand, as its completion will reflect, the spirit of co-operation for the common weal without which the people of the continent cannot rise to the realisation of their destiny.

That Europe, too, will develop a truly European system there can be no reasonable doubt. Up to the outbreak of the war large beginnings had been made in this direction, though those beginnings were, as we have seen, somewhat vitiated by certain fundamental and contradictory conceptions. In keeping with the complexity of her geographical and racial conditions, with the vigour of her manifold human activity and the consequent antiquity of her chequered history, synthesis for her is necessarily a slower and more painful process.

REFERENCE

Readers are also referred to an article by the same writer on *The Economic Development of Australia*. DISCOVERY, Vol. III, No. 36.—ED.

[1] Active negotiations are in progress for the construction of the Darley-Wyndham-Camooweal section of the "inner circle" (i.e. its whole northern sector), thus linking the northern areas of Western Australia and Queensland across the Northern Territory. (See *The Times*, September 6 and 7, 1923.)

Modern Industries—VII

Thorianite and Plumbago

By Captain T. Bowyer-Bower, M.I.C.E.

THE two subjects of this article both happen to be black in their native state; but that is not the reason why I treat them together, nor is it that they stand in any chemical relation to one another. My reason lies merely in the fact that when I visited Ceylon I first came in contact with these essential minerals side by side. The geological formation that originally produced them is similar in every way; but plumbago is formed in segregated veins, and thorianite as an alluvial deposit. Let us consider them, however, under separate headings and take the more valuable thorianite first.

Composition and Use of Thorianite

Thorianite is comparatively a newly discovered mineral, and even now very little is known of its composition and origin. I visited Ceylon soon after its first discovery, but I could gather very little information about it beyond the fact that Professors Crookes, Dunstan, and Coomaraswamy had reported on the crystals submitted to them and had pronounced them to be a new form of thoria quite unique and hitherto unknown to them: they gave it the name of thorianite, but added no definite opinions as to how and whence the deposit came to this particular spot. I was asked to report on the deposit, which covered an area of some twelve acres of hill-side and a stream bed about half a mile long. Before discussing this deposit, it will be as well for us to know something of the relations of thorium, thoria (ThO_2), monazite sands, and thorianite.

Thorium salts are used principally in the manufacture of gas-mantles. The thorium or thoria is obtained generally from monazite sands, which are found in parts of America and the sea-shores of the Eastern Hemisphere. Monazite is very easily detected in the washing-pan, as it appears as a decidedly brown, slimy concentrate; it has a specific gravity of 9·2, and is therefore heavier than most other minerals. Monazite sands yield from 5 to 7 per cent. and even up to 15 per cent. of thoria. It is a very costly business to ship large quantities of sands for the sake of so small a percentage of thoria; hence the high cost of thoria itself. The discovery of thorianite leads one to hope that this will considerably reduce the first costs of this mineral, as thorianite contains 75 per cent. of thoria, thus reducing seven or eight times the transport weight. The specific gravity of thorianite is 10, slightly higher than that of thoria.

It will at once be seen that to find a large deposit of thorianite meant the cheapening of thorium salts and was therefore an event of some economic importance; but nature has not yet yielded any large deposits, and apart from the Ceylon deposit and a few more of lesser size, we still have to recover the major portion of thorium salts from monazite sands.

How is Thorianite Obtained ?

Many of the stream beds are natural concentrates, from the fact that the softer portions of the rock have decomposed and formed pot-holes wherein a varying mineral concentrate is formed. The illustration shows this peculiar formation. In my opinion the denudations and water washings of thousands, perhaps millions of years have reduced the heights of Ceylon considerably. The upper heights have been washed away to the valleys and decomposed by the action of air and water, and have thus freed the mineral crystals; but the surface has been overlaid with a deep deposit known as latterite, which to all appearances looks like a section of fancy-cake, containing cubes, rounds, and oval pieces of soft matter of every shade of colour. It is in this alluvial deposit that the thorianite is found. There are some curious circumstances in respect to the position that thorianite takes in the deposit. The crystals are only found on its surface, never much deeper in it than 12 inches: this seems to prove that the deposit of latterite was of prior origin to the depositing of the thorianite crystals. Then, again, the only two thorianite deposits in the island are both on the south-west face of the watershed and at the foot of the hills at an elevation of about 1,500 to 2,000 feet above sea level. The north-east face of the watershed is barren so far as thorianite is concerned. The bed of the stream dividing the watershed consists of large and small boulders embedded in decomposed latterite. This stream bed gave quite a reasonable return of thorianite crystals. The average yield of the area I placed at ½ lb. of thorianite per cubic yard, valued at 10*s*. 8*d*. per lb. The concentrate recovered from the stream, which I take to be a better indication of the average mineral contents than the wash from the hill face, contained thorianite, monazite, zircon, illumanite, all of heavy specific gravity, which makes their recovery comparatively easy.

Thorianite crystals are deep brown to black, and of cubic structure. Many of the crystals were much waterworn, proving they had been very considerably knocked about during their existence in a free state. A theory exists that they once were encased in rock, but I doubt it. If they ever were, the rock that contained them was one which was very easily decomposed, so that it is at the present day extinct and merely forms part of the existing latterite.

Radio-activity of Thorianite

Thorianite is one of the few minerals that are radio-active. I took a small handful of crystals and inadvertently placed them on a table with my camera, which had a plate ready in position for exposure: the crystals and camera remained on the table all night, and I found when I developed the photo with a picture on it that there were rays of light across the picture. I guessed the cause, and then put another plate in to test my theory. I got the same result, proving conclusively that thorianite was radio-active. Since then this has been definitely confirmed by the late Professor Crookes.

The system of recovering the thorianite from the hill surface and also from the stream bed was similar, viz. by hand-washing in a conical basket and dry-vanning the concentrate—a very tedious and primitive method. Given the best care, the deposit could only have been imperfectly cleaned up, and the vanning shovel, being made of cane basket-work, after a short period of use would allow any thorianite and monazite contained in fine slime to escape to the ground. I found that my steel pan gave me monazite and even gold, which was not to be found in the finished concentrate from the dry-vanning basket.

The Varieties of Plumbago

Plumbago-mining in Ceylon is perhaps the largest mining industry, in fact the only one of importance, in Ceylon. Prior to 1914 the export of plumbago from the island was 570,807 cwt. and the value Rupees 9,047,295; in 1922 it was 216,999 cwt. and the value Rupees 1,631,087. The price varies very considerably and can range from £12 up to £60 per ton according to quality. There are numerous market grades of plumbago—Double X (the best), Large Lump, Small Lump, Coarse Flake, Fine Flake, and Dust. The average carbon-content of the sample greatly controls the price. The best 2X runs up to 92 per cent. of pure carbon, and specially selected even higher, to 96 per cent.; for the lower grades the carbon-contents are seldom below 40 per cent. of pure carbon; below this the sample is not of much value. The peculiarity of plumbago is that the purer it is, the less mark it will make on a clean sheet of white paper. The usual test of quality is to take a pinch of the best quality reduced to a fine dust and smear it with the finger over the surface of a white sheet of paper: if it is of high quality it will not mark the paper, if of medium quality it will show the smear, if of low quality it will leave a deep black mark. The best qualities are used in the manufacture of crucibles, lubricants, and paints, as pure carbon, being practically indestructible, will withstand enormous heat; and in the paint it will coat over the surface so that weather, acids, and other

oxidisers cannot penetrate to the articles painted. The lower grades are used for a hundred and one trades, principally for lead pencils ; black-lead is used for polishing stoves and iron-work. The plumbago is adulterated generally with krissalin (Fuller's earth) so as to give it the desired effect of marking clearly as in pencils, or of leaving a deep black colour over any article as in polishing.

The Primitive Workings

The specific gravity of graphite is 2 ; it is pure carbon, or nearly so, the impurities being generally oxide of iron, silica and alumina. It is found nearly all over the world and in conjunction with other mineral veins, but the mines of Ceylon are perhaps the most important, producing the mineral in the largest quantities and of the finest quality. In Ceylon it is found in segregated veins in the gneiss rocks, and goes to a great depth. The veins are exceedingly irregular in their strike, and just as erratic in width. A narrow streak may suddenly open out and gain great width of vein 5 feet to 6 feet thick, more like a huge irregular pocket of ore ; but the average width mined is generally 1 to 2 feet. The system of mining is primitive in consequence of the irregularity of the vein : much dead work has to be done so as to follow up the indicator, which may, some few feet farther on, give a fair tonnage. With one exception the mines are exclusively under native control. A shaft is sunk on a promising indicator, and then they start groping about in narrow tunnels under the ground just as fancy takes them. In consequence a graphite mine in Ceylon is perhaps one of the most wonderful sights a mining engineer can wish to see : added to the wonder how anyone could work in such a labyrinth of holes and tunnels is the excitement of whether one will ever get to the surface alive again. Thanks to this primitive way of working, as little material as possible is removed, so that many of the tunnels are impassable for an ordinary man, and no plumbago miners are wanted whose stature is larger than that of a small boy ! The mining is absurdly primitive, a windlass is used for hauling, and if the mine is deep, there is a windlass at every 100 feet of depth. The buckets are made of hide and the water is bailed with half coconut shells. I have seen a string of seven boys bailing from an inclined hole with coconut shells, which were handed from one to another full of water up the incline, and at the same time a string of empties was coming back to be refilled. They say that it would not pay to mine in any other way, and I quite believe this on account of the mass of dead work that would have to be done if mined on modern methods. The mining of graphite in Ceylon, therefore, can be taken as unique ; it may well be the most primitive mining in the world. They do not discard their primitive methods when they have the ore at the surface, where it has to be prepared for market prior to shipping. The methods of dressing the ore in Ceylon are a fair match for their mining. The ore is trucked in the crude state to the dressing-

A THORIANITE MINE IN CEYLON.

sheds; the whole process of dressing is done by hand, and the rapidity with which it is sorted is really marvellous. The process is as follows. The ore is dumped on to the floor. The large pieces are put in one heap, those from large to medium in another, and so on down to mere dust, in dozens of small heaps. These heaps are again distributed to hand pickers, who make up each their own heaps according to their fixed grades. At the end the various grades are collected and dumped separately. They are then rubbed and polished so as to detach any small particles of iron oxide and other impurities that may be attached. The masses are then dry-vanned, the clean particles put into barrels ready to be shipped, and the dust falling from them goes to the stamp-flour, together with any residues that come from the previous sorting. These detach all impurities, and the carbons are again separated by dry-vanning, and then, after being polished, are barrelled up as the lowest quality (fine dust). This sorting is really unique, as every particle down to the size of a pin's head is picked by hand out of the mass. The large lumps and large pieces are picked out of the first dumping of the ore and are graded according to appearances. Each piece is brushed by hand to take off dirt and impurities, and then polished with a cloth. It is then graded by appearance into Double X to Single X, or large and small lumps, and barrelled. The appearance of the lumps when polished is wonderful; the large lumps look more like pieces of silver than graphite.

Among the Stars

A Monthly Commentary

Mira Ceti as a Double Star

PROFESSOR ROBERT G. AITKEN, associate director of the Lick Observatory, announces that the famous variable star, Omicron, or Mira Ceti, is a double star. He examined the star on October 19, and found that both components are easily visible, the companion being bluish in colour and fully half a magnitude fainter than Mira. As a careful study of the star in 1903 and 1905 gave no evidence of duplicity, it is probable that the separation between the components has increased. Mira is, of course, a long-period variable and does not belong to the class of eclipsing stars, so the discovery of a companion does not solve the problem of its variability.

Further Confirmation of the Einstein Theory

As is well known, there are three astronomical consequences of Einstein's theory of relativity. These are: (1) the movement of the perihelion of Mercury's orbit, which the Newtonian law of gravitation does not explain; (2) the deflection of light in a gravitational field; and (3) the displacement of spectral lines towards the red in a strong gravitational field. As a matter of fact, the first-named—the movement of Mercury's perihelion—has been familiar to astronomers for years, and has been viewed as strongly confirmatory evidence of Einstein's theory. The second—the deflection of light—was satisfactorily detected on the photographs of the total eclipse of 1919, and again last year. The absence of definite evidence as to the existence of the third effect—the displacement of spectral lines towards the red in the solar spectrum—has long been a stumbling-block in the way of the whole-hearted acceptance of the theory. As Professor Einstein himself admitted three years ago—"If the displacement of spectral lines towards the red by the gravitational potential does not exist, then the general theory of relativity will be untenable." Two distinguished astronomers—Mr. Evershed, who has just retired from the post of director of the Kodaikanal Observatory, in India, and Dr. C. E. St. John, of Mount Wilson Observatory, California—have long been engaged in the search for the displacement, and up to now the results reached by the former have been indecisive, while those reached by the latter have been if anything unfavourable. In a recent paper on "The Einstein Effect in the Solar Spectrum," Mr. Evershed gives an account of his most recent attack on the problem. In 1921 and 1922, as a result of direct observation of the solar spectrum, and comparison between plates of the spectrum of the Sun and of Venus, Mr. Evershed finds a distinct shift towards the red—"a reasonably close agreement between the observed and predicted shift." "These results," he says, "I therefore take to be final in proving that the shift to the red is found in light coming from any part of the Sun. Reviewing the evidence as a whole, there seems to me to be very little doubt that the Einstein effect is present in the solar spectrum."

Almost coincident with Mr. Evershed's announcement is the statement, made on the authority of Professor H. H. Turner in a letter to *The Times*, that Dr. St. John has also, after long searching, detected the shift towards the red. Einstein's theory of relativity is thus immensely strengthened by the detection of the third of the predicted effects.

Studies of the Nebulæ

In his third paper on "Photographic Studies of Nebulæ" (*Contributions from the Mount Wilson Observatory*, No. 256), Mr. John C. Duncan announces the results of some of his observations on prominent nebulæ. The paper is illustrated by beautiful photographs, chiefly by means of the great 100-inch telescope. In the case of the famous "trifid" nebula in Sagittarius, Mr. Duncan states that "the same general character—well-defined dark areas superposed upon bright nebulosity—prevails throughout the whole, and in the neighbouring bright nebula M8 as well. The dark lanes can best be explained by obscuration, but the obscuring material may well be dark extensions of the bright nebulosity." Mr. Duncan has paid much attention to the late Professor Barnard's

dark nebulæ, and his photographs fully confirm those of Barnard. In the case of the famous "North America" Nebula, first discovered by Professor Max Wolf, Mr. Duncan notes that a region in the middle of his plate—in the nebular "Gulf of Mexico"—is entirely devoid of luminous nebulosity, "while the star-density within it is certainly less than a tenth of that within the brighter nebulosity." One main nebulosity at the south-east side of the gulf is in the form of nearly parallel streaks, which are broken by irregular transverse dark markings. Associated with these is a "great arch of semi-obscuring matter." These investigations go a long way to prove the truth of the new view of nebulæ—namely, that the normal nebula is dark, and that luminosity is set up only when there are stars near enough and bright enough to excite the nebulous matter to luminosity or to cause it to shine by reflected light.

A New Cepheid Variable Star

Dr. Tomas Solá, the Spanish astronomer, announced some months ago his discovery of the rapid rise in brightness of a twelfth-magnitude star in the constellation Libra. The star has since been studied at Harvard Observatory, and it has been proved to be a new variable star of the Cepheid cluster-type. It varies from magnitude 10·8 to 12·15, which is larger than usual for Cepheids of this type. The period is less than half a day.

HECTOR MACPHERSON.

Books Received

Mention in this column does not preclude a review.

NATURAL SCIENCE

Eclipses of the Sun. By S. A. MITCHELL, Professor of Astronomy at the University of Virginia. (Oxford University Press, 17*s.*)

The Development of the Sciences. Lectures delivered at Yale University. Edited by LORANDE LOSS WOODRUFF. (Oxford University Press, 16*s.*)

The Chemistry of Rubber. By B. O. W. LUFF, F.I.C. (Ernest Benn, Ltd., 25*s.*)

Farm Soil and its Improvement. By SIR JOHN RUSSELL, D.Sc., F.R.S. (Ernest Benn, Ltd., 7*s.* 6*d.*)

The Principle of Relativity. By ALBERT EINSTEIN and OTHERS. (Methuen & Co., 12*s.* 6*d.*)

The Atom and the Bohr Theory of its Structure. By H. A. KRAMERS and H. HOLST. (Gyldendal, 10*s.* 6*d.*)

The Geology of the Metalliferous Deposits. By R. H. RASTALL, Sc.D., M.Inst.M.M. (Cambridge University Press, 21*s.*)

Principles and Practice of Wireless Transmission. By G. PARR. (Ernest Benn, Ltd., 5*s.*)

Time and Weather by Wireless. By W. G. W. MITCHELL, B.Sc. (The Wireless Press, Ltd., 3*s.* 6*d.*)

Wireless Telephony. By R. D. BANGAY. (The Wireless Press, Ltd., 2*s.* 6*d.*)

Elementary Aeronautical Science. By IVOR B. HART, B.Sc., and W. LAIDLOW, B.Sc. (Clarendon Press, 7*s.* 6*d.*)

Studies in Soil Acidity. By J. L. SAGER, M.A. (Cambridge University Press.)

Newer Aspects of the Nutrition Problem. By F. GOWLAND HOPKINS, Professor of Biochemistry at Cambridge University. (Oxford University Press, 1*s.* 6*d.*)

The Absolute Daily Range of Magnetic Declination at Kew Observatory, Richmond, 1858 to 1900. By C. CHREE, Sc.D., LL.D., F.R.S. (H.M. Stationery Office, 2*s.* 6*d.*)

The Causes of Rhythm in Vital Phenomena. By J. L. SAGER, M.A. (Paternoster Press, Exeter, 9*d.*)

Probité scientifique. Par MAURICE LECAT. (Chez l'Auteur, Louvain.)

Dædalus, or Science and the Future. By J. B. S. HALDANE, M.A. (Kegan Paul, 2*s.* 6*d.*)

Butterfly Lore. By H. ELTRINGHAM, M.A., D.Sc., etc. (Clarendon Press, 4*s.* 6*d.*)

Essai sur la Cause de la Gravitation. Par N. SAKELLAROPOULO. (Le Caire.)

ARCHÆOLOGY, PHILOSOPHY, AND BIOLOGY

The Rhind Mathematical Papyrus. British Museum, 10,057 and 10,058. By T. ERIC PEET, Brunner Professor of Egyptology in the University of Liverpool, etc. etc. (University Press of Liverpool, Ltd.; Hodder & Stoughton, Ltd., 63*s.*)

From Immigrant to Inventor. By MICHAEL PUPIN, Professor of Electro-mechanics, Columbia University, New York. (Charles Scribner's Sons.)

(1) *The Laws of Thought.* (2) *A Realistic Outlook.* By CHARLES E. HOOPER. (Reprinted from the *Philosophical Review.*)

The Philosophy of Proof. By the late J. R. GULSON. Second Edition. (George Routledge & Sons, Ltd.)

Friedrich Hölderlin and the German Neo-Hellenic Movement. Part I. By MARSHALL MONTGOMERY, M.A., B.Litt. (Oxford University Press, 10*s.* 6*d.*)

English Place-names in -ING. By EILERT EKWALL, Ph.D. (Oxford University Press.)

Reviews of Books

A History of Magic and Experimental Science during the First Thirteen Centuries of our Era. By LYNN THORNDIKE. Vol. I, pp. xl + 835; Vol. II, pp. vi + 1036. (New York: The Macmillan Company, 1923.)

It is not easy in a short space to do justice to this very lengthy and learned work of scholarship. The title is a little misleading. Of a history we expect something more than a survey of material, viz. the analysis of that material and the tracing of the various threads of development. On the other hand, without such a preliminary survey history cannot be written, and this, though essentially what the Germans would call a *Vorarbeit,* will be an indispensable instrument to the future historian of

magic. It is a work of real learning and scholarship, and the particular task which Professor Thorndike has performed will not have to be done again. It should perhaps be noted that it does not quite cover the whole field of mediæval magic. There is nothing about what may be called the legendary and popular side ; the theme of such books as Comparetti's *Vergil in the Middle Ages* is not touched. It is true, again, that the witchcraft superstition falls outside Professor Thorndike's period ; but the ideas which haunt the inquisitors' handbooks, such as the *Malleus Maleficarum*, are rooted in the demonology systematised by the scholastics of the twelfth and thirteen centuries. Again, we might have expected some discussion of the causes of the judicial prosecution of magical practices which begins in the thirteenth and becomes prevalent in the fourteenth century, particularly as Dr. Thorndike convincingly demonstrates that the hostile attitude of the Church towards early science has been unwarrantably exaggerated. Again, what may be called the magical interest in archæology and the very characteristic mediæval belief in talismanic statues, which is common alike to Christianity and Islam, is not glanced at. A history of magic would also, I think, illustrate the sources and continuity of tradition from the history of those magical and medical recipes and charms which reappear, substantially identical in title and content, in different centuries and places. I am thinking of such documents as *The Sunday Epistle*, which first occurs in a document of the sixth century, was certainly in use in the German-Danish war of 1861 and, I think I am right in saying, was picked up on the battle-fields of the Great War.

But it is perhaps more profitable to review what the book contains than to grumble about what it omits. It is not indeed a history, but a survey. Starting with Pliny, the first volume reviews in turn the contents of the main writers or groups of writings, which are germane to its subject, up to the sixth century. The introductory chapter is weak and it is not quite what was wanted, which was rather something of the nature of the Historical Introduction in Cumont's recent study of *After Life in Roman Paganism*, viz. a sketch showing the trend of development in the philosophical and religious point of view. The new Stoicism connected with the name of Posidonius marks the point of departure when the pendulum began definitely to swing from the scepticism of the post-Aristotelian Peripatetics and Academy in the direction of credulity and mysticism. In deprecating the quite unhistorical contrasts, which have often been drawn by interested motives, between the temper of Christian and pagan thought under the Roman Empire, Professor Thorndike is indubitably right. Both pagans and Christians start from the common mental background of their identical environment ; he should therefore have made clear what that background was and how it came to be there. Of the four main obstacles to scientific development, three are certainly not to be laid to the specific charge of Christianity, viz. astrology, demonology, and geocentric physics. The fourth, the dogmatic and literal belief in the narrative of Genesis, which so far from being removed was riveted afresh upon Europe by the Reformation, with its apotheosis of Holy Writ, is a purely Christian obstacle which has disappeared almost within living memory.

The summaries, however, of the contents of the various writers and kinds of literature seem to me both accurate and skilful. Where I have knowledge of the authors concerned, I feel that a reader who had not would gain a very fair general idea of what was in them. The bibliographies and notes will further tell him how and where to find out more. These are full and good, and the usefulness of the book is enhanced by the great trouble and care taken with indices and references. There are naturally points of detail about which I should disagree with Professor Thorndike, but upon the whole his judgments seem to me sensible and fair. I could wish that he had said something about the magical papyri ; had he included them in his survey, he would, I think, have avoided a foolish remark upon p. 28. Less important is the omission of any reference to the books of divination by involuntary motions of the body which still circulate among the vulgar in many lands, but go back to Pseudo-Melampus.

As we get on to the Middle Ages, the guidance of Dr. Thorndike becomes more and more valuable, for much of the voluminous material is relatively inaccessible. Apart from anything else, his bibliographical work upon the MSS. is an achievement all the more remarkable in view of the obstacles necessarily imposed by Time and Space upon such researches by an American professor. The second volume in particular, which deals with the twelfth and thirteenth centuries, is a storehouse of information for students of the history of magic, science, mediæval thought and literature, and much of it is information which has not previously been accessible. To the general reader the most interesting point, which seems to me firmly established, is the setting of Roger Bacon in his right place as a scholar belonging to his age rather than a genius who outstripped it.

Of mediæval learning in general it is natural that Dr. Thorndike, who has laboured so long and lovingly at it, should take a favourable though not an extravagant view. I confess, however, that I retain at the end my impression of futile erudition and misdirected labour. For the environment which conditioned and hampered learning, there are, of course, historical reasons and excuses, but in a favourable survey of some of its greatest scholars I miss any example of that true scientific temper of mind which is compatible with a man holding some particular erroneous views or even foolish beliefs ; but when it occurs in a Thucydides or, to take a mediæval example, in the Moslem Alberuni, is quite unmistakable. Indeed two growing convictions have hardened as the result of my reading this book. Firstly the immeasurable intellectual, as well as literary, superiority of Moslem civilisation over that of Europe in the Middle Ages, and secondly the degree to which the practices and beliefs of European folk-lore have their roots, not in immemorial antiquity, but in the learned tradition.

W. R. HALLIDAY.

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